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The New Outlook for the Live Stock Industry in East Africa

The Report of the Meat and Live Stock Inquiry Committee (Kenya), which is summarized elsewhere in this number, is of great importance. It can be read with interest by everyone who has the welfare and development of Kenya at heart, and it demands close study by European stockowners throughout East Africa, and by administrative officers who represent the interests of native stockowners. The report advocates two schemes which, if they are successful, will make a great difference to the outlook of all those in and near Kenya who deal with live stock, and which, in order to be successful, will demand the wholehearted support of live stock owners. The matter, too, is urgent, for not only are the schemes relatively big, but one is to come into operation almost at once, while it is recommended that the other start within three years.

The Committee appears to have possessed unusual initiative, and they were certainly fortunate in having as secretary a man of such outstanding ability, experience and energy as Mr. R. Daubney. Perusal of the terms of reference shows that an ordinary committee could have acquitted themselves with normal distinction by turning out the all-too-common type of report which, while representing some sort of advance, in reality leads nowhere. We remember that an influential committee in Tanganyika Territory some years ago considered in detail the subject of overstocking, and put forward a carefully compiled report which led to no practical results. It is refreshing therefore to read on page 2 of the Kenya report that "certain of the recommendations, such as

those concerning the Liebig and Imperial Cold Storage projects, have already been implemented by Government during the session of the Committee." While reading the report one forgets terms of reference and finds two schemes emerging: one, provision of an outlet for the hitherto unmarketable general run of native cattle; two, provision of a remunerative market, not only for the better types of beef cattle, both native and European, but for pigs and sheep as well.

The focus of Scheme I is indicated by para. 39, which reads: "The agreement with Messrs. Liebig's (Kenya) Limited was eventually signed by His Excellency the Governor on the 18th December, 1936." This means that a factory is now going up near the Athi River where, it is expected, 30,000 head of cattle will be converted annually into corned beef, meat extract, cooking fat, tallow, hides, and various by-products. Two things are clear: (1) the factory can only operate successfully if this large number of animals be forthcoming at a price which, under present conditions, is about Sh. 30 at the factory for an ox in good condition, weighing 750 lb. (inferior cattle, of course, being considerably cheaper); (2) in the pastoral native reserves it has been impossible, in the absence of adequate markets for slaughter stock, to formulate any policy of economic development which would utilize to their full extent the available natural resources in live stock and grazing lands.

Now that an adequate market is in sight, will it be possible to persuade the natives of overstocked areas to make full use of it, so that not only is the factory a financial success, but the overstocked land becomes relieved of a burden of superfluous animals and rises in fertility at the same time as the beasts it carries improve in condition and quality? We fear there is a very hard task for somebody, and that drastic measures will be necessary. But grave ills demand drastic remedies, and the report of the Agricultural Commission of 1929, under the chairmanship of Sir Daniel Hall, merely emphasized what was already well known: how grave is the ill of overstocking in certain native reserves, and how it can only be dealt with fairly if a market for surplus stock be available. The remedy must be attempted, but we entertain no pious hope that the animals will be forthcoming voluntarily for the prices offered. We have noted, for example, almost with dismay, in recent trade reports from Tanganyika Territory, that at the Arusha markets the prices of oxen averaged over Sh. 50, and that supplies were short. We do not believe that natives, as a whole, benefit by the price of cattle being high; we believe the best interest of the non-European community is served when there is a large turnover of stock at low prices, as this means cheap meat for all, and economic utilization of herds. We do not know by what means the Kenya Government proposes to create a current of cheap beef from the native reserves adequate to meet the demands of the export trade in addition to those of internal consumption (which will go up if the price of meat comes down), but we most earnestly hope that the means will be found.

The second scheme is an appeal to European farmers to realize that Kenya, if it be not actually the finest, is one of the finest stock countries in Africa, and that, therefore, it is capable of producing carcasses of the highest class (beef, mutton, and pork) suitable for export as chilled and frozen meat. Illustrative of the good grazing of the Colony is the quality of the carcasses turned out every day from Nairobi Abattoir. While on a visit to Kenya, Dr. M. H. French, of the Tanganyika Veterinary Department, was permitted to carry out some investigations on

the actual and proportional weights of the various parts of the body of Kenya cattle, the results of which revealed two points of particular interest: the first, that pure native cattle of the Boran breed can, under European management, be brought to the same weight as grades at from five to six years of age, on grazing alone, which speaks well for the quality of this native breed; and the second, that dairy grades can reach a dead weight of 549 lb. at 36 months or less, again entirely on grass. The Committee therefore accepted the view that both native and grade cattle of Kenya offer foundation stock from which animals suitable for the English chilled beef market could readily be produced by judicious crossing to a beef breed such as the Angus.

Being assured that a determined and prompt effort by European cattle raisers to produce good quality beef would speedily result in an annual supply of not less than 50,000 cattle being available for a Cold Storage Factory, the Committee turned its attention to pigs and sheep. It was fairly obvious that as the result of a special effort by pig-breeders, Kenya ought to be able to produce at least 10,000 porkers fit for freezing and export each year. The question of mutton production was not so easily answered, but the Chief Veterinary Research Officer outlined a feasible plan for fat lamb production by mixed farmers (rather than by large flock-owners preoccupied with wool), which would result in a regular large supply of these animals being also available for the factory.

Although the main supplies for the factory envisaged by Scheme II are European owned, the fact is not lost sight of that certain native reserves can also provide quantities of cattle suitable for freezing and/or boning, and that within the Colony there is a large undeveloped asset in the shape of some three million unimproved native sheep, some of which can, by reason of the excellent pastoral conditions under which they are maintained, be readily brought to a productive stage by grading-up with Merino rams.

At this stage we leave our consideration of the report. Although we think that great difficulties are inherent in both schemes, they are not insurmountable, and we therefore congratulate the Committee on presenting to Kenya an opportunity for developing its pastoral industries that cannot be lightly discarded.

H. E. H.

The Price Outlook

The economic scene, as it appears to primary producers, has altered considerably since the depression and now presents a much more pleasant aspect. In part this is due to droughts and deliberate restriction of production, and in part to re-armament programmes. Prices have been climbing for some time and the rise has been so general that it cannot be explained by conditions of supply and demand for individual commodities. Now is an appropriate time to take stock of the position.

In an article in the *Economist* of June 13, 1936, the price situation was discussed at length. It was pointed out that depression was being superseded by an expansionist mood. "Pure pyschological expansionism, however, is useless by itself. It needs to have a freely increasing supply of money to feed on." The fundamental basis of monetary expansion is, even in these days, the gold reserve of the central banks. The production of gold has increased by leaps and bounds in the last few years. The Union Corporation put it at 31 million fine ounces in 1935 as compared with 20 million in 1929. "The probable increase of production in South Africa and Russia alone will lift world

production above the 40 million fine ounces mark by 1940." At the same time, gold has been transferred from non-monetary to monetary uses to such an extent that world monetary stocks have increased from 553 million ounces in 1929 to 734 million ounces in 1935.

Now it has generally been the case in the past that increasing gold production has been associated with a rising price level, and vice versa. But in this case there is an additional factor, namely that Britain (and most other countries, too) has devalued her currency in relation to gold. The sterling price of gold is now about 140/- as compared with 85/- in 1929. Some idea of the importance of this will be gained if we suppose that all currencies have been similarly devalued. The world stocks of monetary gold would then be:—

1929: 553 million ounces at 85/- = £2,350 millions.

1935: 734 million ounces at 140/- = £5,138 millions.

The increase is no less than 119 per cent. The materials, therefore, seem to be in existence for a very considerable rise in prices. There appears to be plenty of justification for the *Economist's* conclusion that "unless the lessons of all monetary history are falsified, a very large rise in prices is in prospect."

Mr. J. M. Keynes, in the *Economic Journal* of September, 1936, is somewhat more moderate in his estimate of the prospects. He draws attention to the astonishing progress of gold mining in Russia. "The Report of the Union Corporation takes seriously the claim that by the end of the present year the Russian output will be at the rate of ten or even eleven million ounces per annum, worth £70,000,000. At the rate of eleven million ounces, the Russian output would be approximately equal to the South African."

On the other side, however, the effect of the large increase in production is being retarded by a preference for liquidity on the part of holders of currency and by maldistribution of gold. "Meanwhile, the influence on prices is likely to be steadily upwards."

Here and there, however, one comes across a warning that we may be not far from a descent into the trough of one of those cyclical movements which are spoken of as the trade cycle. It is well known that business conditions show more or less regular ups and downs. In the *Economist* of March 6, 1937, the high and low peaks of prices between 1864 and 1909 are given as follows:—

High.			*Low.*
1864	...	...	1870
1873	...	...	1879
1883	...	...	1886
1891	...	...	1896
1900	...	...	1903
1907	...	...	1909

The average duration of the cycle is thus about eight years. The post-war booms of 1920 and 1929 may have continued the series after the interruption of the war, and we are now experiencing a spurt of prices eight years later. Are we to look forward to a recession shortly to a low point about 1942? In recent weeks we have seen signs of weakness in a few commodities, but this may merely indicate that speculation on future rises has been temporarily overdone. It is possible, of course, to have short-period rises and falls in a curve which over the long period is climbing rapidly.

V. L.

The Disposal of Sisal Waste

Mr. Eric Linklater defined a baby as "a biological system of uncontrolled apertures". Not only the human baby,

however, goes through a messy excretory stage early in its development. Infant industries often do so too, with the difference, making it less excusable, that they sometimes reach a robust maturity, or even fall into senile decay, before learning to be properly clean. When at last (if not too late) they decide or are compelled by public opinion to tidy up as they go, they and the world at large not uncommonly profit in unexpected ways by the new-found habits of methodical cleanliness. Familiar examples of this in the history of great industries come to mind immediately: coal tar and its derivatives, sulphate of ammonia from gas-liquor, basic slag from steelworks tips, potash from flue dusts, cheaper steam-raising from smoke consumption, rare metals from rejected mine-tailings, vitamins and fertilizers from fish waste, feeding-stuffs from the carcasses of Antarctic whales. The lesson, though it is a stock subject for popular-scientific magazine articles, is usually forgotten at the birth of a new industry, and more than this can hardly be looked for from pioneer enterprise in young tropical countries, where many sorts of crudity and inefficiency have to pass for a time until leisure and settled conditions bring about a raising of standards.

Attention is drawn to an article in this issue describing a successful example of an attempt of this kind to raise standards in the sisal industry; and it is, happily, an example also to add to the list above, of uncovenanted benefits accruing, not only to the industrialist himself but also to his workpeople, from the organized disposal of an otherwise obnoxious "excretion"—sisal waste. Even this intractable and incombustible form of vegetable residue can, it has been shown, be converted into humus and irrigation water, to the advantage of the land and of those who live by it.

Almost every sisal estate is faced with this problem of dealing with wet waste, and as the solution of it described from Taveta will probably be tried elsewhere, it is as well to point out that there are certain conditions at Taveta favourable to the process that may not be so fully operative in other districts and which may have to be provided artificially before the conversion to humus goes quite so smoothly as it seems to do there. One of these is the very dry atmosphere, which no doubt materially assists the heaps to reach the optimum moisture content from the wet extreme from which they start. Another, perhaps more significant, is that the soils of that area are rich in lime carbonate, a property that may be expected to be reflected in the composition of the sisal pulp—a point on which it would be interesting to have analytical data. The spring and well waters of Taveta are known to contain alkaline-earth bicarbonates to the extent of about 165 parts per million. The maintenance of a slightly alkaline reaction in the heap is a necessary feature of successful composting processes, and whereas there it happens automatically, elsewhere (e.g. on the acid red soils of the sisal districts of the coast) the desired condition will probably have to be brought in by generous additions of wood ash, milk of lime, or finely ground limestone. Acid and wet material will be liable to turn into something like sour silage rather than humus. This point should be borne in mind by the reader from outside the Taveta district, by way of adjustment to the understanding of Major Layzell's article.

The Editor would be glad to have communicated to him, in the form of articles or notes for publication, any parallel experiences in the composting of sisal waste on other estates.

G. M.

Soil Conservation and New Settlement

When new land is being brought under the plough or under the hoof for grazing, the soil conservation measures that are to be taken should be ready thought out and applied from the start, so that they begin to operate immediately for the protection of the virgin soil in its first season of utilization. If the new settler waits until the activities of the soil-shifting devil begin to bring themselves urgently to notice, he has waited too long.

The point of this is driven home by the following passage, quoted by permission from a letter of advice sent by an Agricultural Officer to the sponsors of a new settlement project in a highland area in East Africa:—

"Regarding the soil erosion, if adequate measures for its prevention are not carried out, your farming scheme will fail as the German settlement has failed at Lupembe. At Igololo the farmers have packed up and gone, as the farms have produced nothing since the first crop. One farmer is staying and is continuing to harvest excellent crops. This farmer is the *only* one who contour-ridged his farm six years ago. The soil of that section of Lupembe is better than yours, and soil erosion has killed most of it. As I suggested to you, your people coming in should not be allowed to think in any other terms but in terms of contour ridges right from the start. To emphasize this, I should mention that in America many leading banks now refuse to lend money on the security of farms that are not contour ridged."

G. M.

The Missing White Storks

The ornithological observatory at Rossitten, East Prussia, has sent out an interesting communication in the form of a questionnaire. Whereas in each of the last three years the White Storks breeding in that Province have numbered about 33,000 birds, this year at the end of April, which is some weeks after the normal date of the birds' return from wintering in Africa, only 12,000 had arrived. Thus some 20,000 storks from this one Province alone are dead, diverted from their usual course, or delayed somewhere on their journey. We know from the recovery of ringed birds that East Africa is visited regularly by East Prussian White Storks, so that our local observations might well make a valuable contribution to the inquiry set on foot by the observatory. Particular questions are:—

(1) Has anyone noticed any peculiarity in the habits or movements of White Storks during the last six months?

(2) Does anyone know of many White Storks being found dead anywhere lately?

(3) Are flocks of White Storks still about anywhere in East Africa, or have any been seen since the beginning of March?

(4) Have any ringed storks been found locally this season?

If any readers of the Journal who are interested care to send replies to these questions to Mr. R. E. Moreau, Amani, he will be glad to receive them and collate them for transmission to Rossitten. Even negative replies would be of some value.

Essays in Applied Pedology

I.—Soil Type and Soil Management in Relation to Plantation Agriculture in East Usambara

By G. MILNE, *M.Sc., F.I.C., Soil Chemist, East African Agricultural Research Station, Amani, Tanganyika Territory.*

Usambara is the only one of the mountain regions of East Africa that can be sighted by the traveller at sea. Its eastern frontage is imposing as seen in silhouette from Tanga, though no points on the skyline go above 4,000 feet, and the general height of the mass (it is a deeply scored plateau rather than a mountain chain) is only a little more than 3,000 feet. On the main routes into the East African interior such altitudes are traversed in hot, dry and difficultly habitable thornbush country. Yet East Usambara is a comparatively cool and very moist upland, often hidden in cloud, and it carries extensive continuous stands of evergreen forest. The high humidity, the high but somewhat variably distributed rainfall, and the unusually sharp drop in temperature that here marks the ascent from sea-level, are all attributable to one cause: the abrupt uprearing of the boundary escarpments, at distances of no more than 25 to 30 miles from the coast, against the incoming moisture-laden winds.

This forest-clad mountain land, close to an ocean port, was naturally one of the first pieces of country to attract exploitation after the German Protectorate had been set up by local and international treaties in the late 'eighties. Its most obvious resource, timber, was not easily tapped, for amongst the wealth of tree species those of recognized commercial value were few and the individuals costly to extract except from the more accessible parts of the foothills. The amply capitalized companies that were formed to open up Usambara therefore had agricultural crop production as their main aim, and the forest as such was no asset to them; it led to their choice of the ground, but afterwards was only in the way.

According to the tropical agricultural theories of the time[1] the luxuriance of tree growth in a tropical forest signified a correspondingly abundant fertility of the ground when put to agricultural use. Under such a dense standard of tall trees as adorned East Usambara, the planter might assume the fundamental factor of *soil* to be lavishly in his favour; he was excused from bothering very much about that side of his business. The available capital should be expended over as much land as could be clear-felled and burnt, planted and maintained till the first harvest; high yields were counted on, and it was no part of the duties of development to incur expense in keeping the land in good heart, still less to have to contend against original defects in fertility. The land itself, virgin and almost without native inhabitants except beyond the edges of the great forest, could be alienated in large geographically defined units in which the clearings for planting could be sited as convenient.

As to choice of crop, opinion was unanimous that on the 3,000-3,300 ft. plateau it should be coffee. (On the lower ground of the foothills and main approach valleys a variety of other crops was tried. The foothills are, however, a terrain with quite different soil conditions, with which in this essay I am not concerned.) About the wisdom of specializing on coffee there appear during the first ten years to have been no doubts. The obvious species to be used was *Coffea arabica* L. It was a native

[1] Referred to by a German writer of the succeeding generation as *Märchen* = fairy tales.

of an African forest; there were examples of its extensive cultivation in forest clearings in tropical Asia; and on these qualifications its ability to earn dividends in Usambara was not questioned. The fate of coffee in Ceylon on very similar soils does not seem to have been taken as a warning, though *Hemileia* leaf-rust was already by 1894-5 becoming an anxiety here in Usambara also [1]. At first there was trial of Liberica coffee also, on a small scale. This species was, however, soon relegated to the lower altitudes, where for a time it was extensively planted, on ground later occupied by sisal or rubber.

The Early Developments

Beginning in 1891, the plantation policy thus envisaged was entered upon vigorously, the immediate difficulty of lack of skilled labour being overcome by the importation of Javanese and Chinese coolies. By the 1st January, 1902, six different enterprises, having had lands put at their disposal to a total of 21,000 hectares, were officially returned as having cleared and planted 1,815 hectares (4,450 acres) or 8.7 per cent of their holdings; of these plantings, 1,340 hectares (3,280 acres) were then *ertragfähig* (in bearing) [2]. Subsequent expansion was comparatively small: two years later the area had increased only by 220 hectares, and this was about its limit. The age-distribution of the plantings in 1901 on the earliest established and largest of the undertakings is set out in the company's report for that year:—

	No. of Trees.
Four years old or more	381,378
Three years old	110,021
Two years old	73,717
One year old	44,200
Less than one year old	105,850

The year's yield was 57,211 kilograms of clean coffee, i.e. 57 tons. Calculated on the plantings four years old or more, without allowance for three-year-old trees, this represents about 2 cwt. per acre, or 150 g. (5.3 oz.) of clean coffee per adult tree. The price realized in Germany—low prices for primary products in general being bewailed at the time—was 1,100 marks (£55) per ton.

The history of these estates during the next ten years, up to the outbreak of war, can be traced fairly well in the official returns, the reports of company meetings [3] and the agricultural-scientific controversies of the time; and particularly also in the directions that were taken by the investigations of the Amani Research Station [4] [5], which was founded in their midst on ground gifted by one of the interested firms in June, 1902. To write the story in a manner to do full justice to the lessons it conveys would be beyond the scope of this article, but as the agricultural experiences of the area are, as it were, the moral of my essay in applied pedology, I summarize them shortly.

The Decline of the Plantations

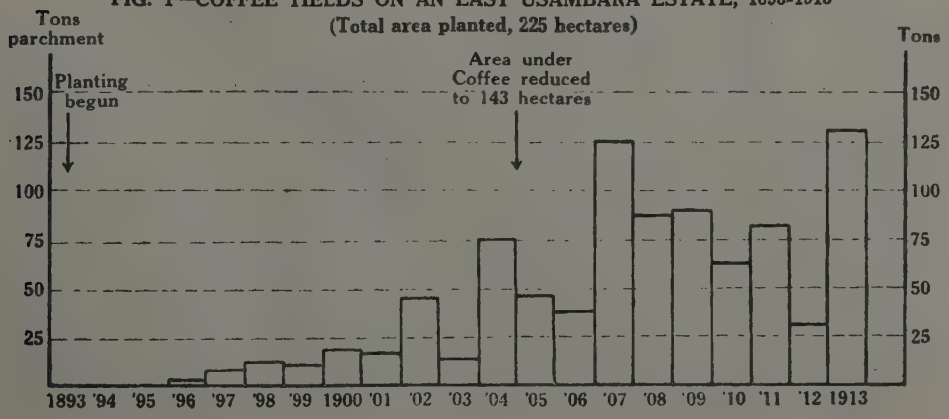
In 1902 doubts were expressed by an experienced agricultural chemist, Wohltmann [6], whether Arabica coffee would do all that was expected of it in East Usambara unless careful attention were paid to soil improvement. He based his opinion on soil analyses and analyses of the ash of Usambara coffees; but, partly owing to the weakness of the soil chemistry of the time, his case was not well made out from his figures, and he was vigorously assailed for his pessimism by the botanist Zimmermann [7], then newly appointed to Amani from the Dutch East Indies, and by the geologist Koert [8] [9], who had just concluded a very able field survey of the local soils. This was a strong combination. Zimmermann attributed to lack of shade and exposure to wind such disappointments as were admitted. (Until then the plantings were mostly unshaded; a universal campaign of *Grevillea* interplanting

began forthwith.) He also referred to the need for cover crops, and to pests and diseases, of which he listed a formidable number; but he was to set about devising controls for them at Amani. Koert found one of the two principal soil types (his *jüngerer Rotlehm*) of very satisfactory fertility, and so it is; but he himself mapped it only on the most precipitous and rocky slopes, which are in practice too steep for cultivation except patchily for native food crops. Nevertheless, Engler [10], who made some of his classical studies on vegetation types in this area in 1903, advised against further commitments in coffee in rain-forest clearings, and urged that cinchona, camphor and tea should be kept well in mind as perhaps destined to yield better than coffee.

By 1905 the companies were explaining to shareholders that yields were unfortunately not up to programme owing to unfavourable weather conditions, labour difficulties and pests (borer was getting bad), but that the less promising areas were being given up and better cultivation was to be given to the remainder. Interest in manuring grew, but artificials gave negative results, and the hope lay with composts based on cattle-keeping. At the same time, the directorates set about raising fresh capital for going into sisal (which from then onwards earned their profits, but on quite different soils on the coastal plain and foothills), and rubber. In 1908 a new-year editorial in *Der Tropenflanzer* said that "coffee in Usambara was shrinking more and more," and pointed out that there was by then no coffee company that had not been driven to put some of its eggs in other baskets. (A bright spot in the coffee outlook was the great promise of the new enterprises on Kilimanjaro, then being embarked upon by a repetition of the Usambara policy of 17 years before.) In the same year one of the estates, perhaps not fully representative as it lay on an isolated block of the plateau eastward of the rest, abandoned its whole coffee area of 550 hectares and went into rubber, later to change again into oil palm. The remainder continued in production on reduced acreages till the war, with a fairly considerable total output but with fluctuating yields that on the average barely covered costs.

The amounts of parchment coffee shipped each year from 1896 to 1913 are on record for one of the estates, which had started in 1893 and carried its plantings to 225 hectares (550 acres). They are shown in Fig. 1. From 1905 onwards the

FIG. 1—COFFEE YIELDS ON AN EAST USAMBARA ESTATE, 1893-1913
(Total area planted, 225 hectares)



yields are from 143 hectares (350 acres) only, as 82 hectares (200 acres) had been abandoned after the 1904 harvest and turned into cattle pasturage to aid the provision of manure.

It seems that the reduction of acreage in 1904 and the introduction of cattle husbandry led a year or two later to a period of improved output, averaging over the next nine years 77 tons parchment, representing 3.5 cwt. clean coffee per acre. On this particular estate the poor yields of the young coffee as it came into bearing may have been due to bad planting or other technical mistakes; imported Asiatic labour was not used here, and the company had some quarrel with its first manager. But it was the general experience of the district that production was below what had been counted on, and more often than not failed to give a margin over the year's expenses.

Alternative Crops, and Soil Investigations

In the meantime small trial plantings of tea, cinnamon, cardamoms, cinchona, camphor and Robusta coffee varieties had been made on one or two of the estates and at Amani. The main preoccupation of everybody at that time, however, was rubber—Ceara rubber, *Manihot glaziovii*. This also did poorly on the ex-coffee clearings, and the spectacular extension of rubber planting in 1906-12 took place entirely at lower altitudes and outside the area being discussed. By 1914, therefore, the crop (if any) that was to succeed Arabica coffee on a large scale in the forested plateau region had not been decided upon; some of the newer fancies grew well enough, but their period under observation had been short and nothing had emerged about their economics as perennial crops. There was also little evidence that the experience with coffee had brought home its lesson, namely that large-scale exploitation of this forest land under *any* crop, without a revision of the old assumptions about soil fertility, was likely to lead to financial loss.

The soil investigations published from Amani up to 1914, except for Koert's agro-geological survey of 1902 already mentioned, amounted to little but a few analyses and abortive field trials by the Institute's chemist, Lommel, who was overburdened with other analytical work and made no claim to be a soil specialist. They contributed nothing to the problem. Another Amani worker, however, Eichinger, who combined field ecological surveys with pot-experiments on the manuring of annual crops, had arrived between 1910 and 1917 at conclusions representing a great advance in insight into the constitution of the Usambara forest soils. He did not publish these until long afterwards, in 1926 and 1933 [12]. Written after mature reflection and with knowledge of the progress made by soil science in the meantime, these papers of Eichinger's throw much light on the agronomic experiences of Usambara plantations. They will be referred to along with the results of the later Amani investigations in the sketch of soil conditions given below.

The Abandonment of Arabica Coffee

Briefly to carry forward the history of the plantations to the present day, it has been a tale of renewed but gradually extinguished hope for their revival as Arabica coffee concerns during the decade after their long period of war-time neglect; of further considerable losses of capital and waste of hard work; of yields dropping to near vanishing point, while still fluctuating tantalizingly from year to year; of heavy mortality of old trees and complete failure of new plantings in their place; and, within the last few years, of the abandonment

of nearly the whole of the coffee plantings as useless for their purpose.

It has seemed unreasonable to suppose, however, that the East Usambara forest clearings provide land that is quite incapable of any form of profitable agricultural production. There is at present in progress an attempt to discover whether the plantation industry can be revived on a changed basis, namely the belief that a variety of other crops can be found that yield products demanded at good prices by the world's markets, and that under a more rational policy of soil husbandry can be made to accommodate themselves to the conditions that have defeated Arabica coffee. The testing of a programme on these lines has been entrusted to the Research Station at Amani, the perennial crops chosen for trial being cinchona, aleurites and Robusta coffee, with derris as a short-period crop to be treated intensively. No one of these crops is being looked upon as a possible single-string venture to which an estate might devote itself exclusively. The hope of better success than in the past is considered to lie in a conjunction of all four of them. If the hope proves to be well founded, there is prospect that the abandoned clearings will come to be reoccupied, and the forest will not after all have been sacrificed in vain.

The Forest Soils

We have then a record of agricultural disappointment on the forest soils of East Usambara, but a present determination not to be beaten. It is time to inquire to what extent the mistakes of the past have consisted in sticking too faithfully to Arabica coffee, and to what extent in an erroneous estimate of the soil's fertility under the type of management hitherto adopted. An analysis of the first half of this question, from the viewpoints of the economic botanist, physiologist, pathologist and economist, would be a work of the greatest value to many in East Africa who have commitments in coffee. An early demand of those who undertook the task, however, would be to have the second question answered first.

I therefore attempt below a summary of our present knowledge of these soils from the pedological standpoint, and endeavour to apply the findings to the practical problem.

Topography

The topography of this part of the East Usambara highland is, as has been already stated, that of a strongly dissected plateau at from 3,000 to 3,300 feet above sea-level, with occasional higher ridges. The upper Sigi River and its feeders lie in steep-sided deep and narrow valleys in which swampy and rocky reaches alternate. At principal valley junctions the swamps lie in rather broader basins a few acres in extent, parts of the lowest slopes of which have been used for siting nurseries. Otherwise, level or nearly level ground is non-existent. The angle of the slopes moderates towards the tops of the broader ridges, but most of the spur ridges are narrow topped, and there is very little of the total land surface of the area that is not steeply inclined.

Geology

The country rock is the so-called Basement Complex of ancient metamorphic rocks, here mainly biotite-hornblende-garnet-gneiss, an acid rock. It contains much quartz, which makes up the coarse and fine sand fractions of the derived soils. There are also local occurrences of granulite, amphibolite (a basic rock) and a pegmatite of composition like granite. The silicates include both lime-soda and potash feldspars, and the accessory minerals include apatite and pyrite which contain phosphorus and sulphur. From the composition of these rocks there is thus no

particular indication of abnormality in soil composition.

The plateau is an ancient land surface, which has gradually been elevated and in the meantime has been remodelled by active stream-erosion. Outcrops of rock are not common on the plateau except on the steeper valley slopes and along the watercourses, though one or two of the higher ridges break down in spectacular rocky cliffs. The main boundary escarpments, which have been kept "young" by the continuing elevating movements, differ fundamentally from the plateau as sites of soil formation. On the plateau the rate of soil formation and of rock decomposition at depth has more than kept pace with erosion, so that there is a thick mantle of red earth nearly everywhere, which has attained equilibrium with the climate and with the forest. On the scarps the steep angle of the decomposing rock faces prevents equilibrium from being attained and makes for "younger" soils, i.e. soils less advanced in decomposition.

Climate

The forest region "enjoys" (in the standard phrase) a rainfall of 2,000 mm. (80 inches), put at a round figure. It may fall short of this by as much as 30 per cent in a dry year or exceed it by 20 per cent in a wet one. Every month, except sometimes February, usually has a few rainy days, and these fall together as long wet spells during late March to early June (the long rains) and to a less extent and more uncertainly in late October to mid-December (the short rains). Differences in exposure, aspect and nearness to the escarpments make for considerable local variety of experience in the events of weather, but in a general way the area is climatically a unit. Atmospheric humidity is high even in rainless weather.

The shade temperature in the open has a comparatively narrow range about an annual mean of 19° C., the highest maxima of 28-30° C. occurring in February and March, and the lowest minima around 14° C. in August. Occasional temperatures below 10° C. are on record, but never frost. Inside the forest the temperature range is less, the maxima being about 3° lower than in the open [13].

Temperatures in the soil under the forest floor vary only within the narrow range from 17.5° to 20° C.

Vegetation

For the present purpose this is sufficiently described as an evergreen forest of a large number of tree species up to 150 feet in height, whose shade completely excludes grasses and annual herbs. There is a wealth of lianes and epiphytes, ground ferns and a good deal of shrubby undergrowth [14]. (See photograph, Fig. 2.) Leaf litter does not accumulate, as it is quickly consumed by fungi and lower animals. Fallen trunks decompose gradually into a very acid brown humus, and ultimately disappear.

Morphology of the Soil

The shelf roads that have been cut along the valley slopes expose the profile to study in all parts of the district, and though there are of course many variations on the theme it is evident that, broadly speaking, there is only one soil type on the forested plateau. Decomposition has penetrated deeply, both into the massive rock and amongst what were once piles of scree, producing a "red earth" that is rarely less than 2 metres thick, and often much more. At depths from the surface depending on the degree of slope—sometimes no more than 50 cm., sometimes 2 or 3 metres—the subsoil consists largely of rotten rock brash which preserves the original seamed structure and mineral mosaic of the gneiss, though all the minerals but quartz are chemically decomposed, the colour pattern

has changed to yellow, rusty, pink and black, and the fragments merge imperceptibly into the red-earth matrix in which they lie. The colour of the whole profile as seen in a fresh exposure, except for the top few centimetres, to which reference will be made later, is a uniform bright tint which may be brownish yellow, brownish orange, brownish red or brownish pink, rarely a full red such as is found in the foothills below. These colours are due to varying states of hydration of ferric oxide, mixed with colourless hydrated alumina and yellow-stained quartz and modified by traces of manganese oxides. The perpetual moistness of the soil at all depths has prevented the development of the maximum red colour of dehydrated oxide of iron, but the penetration of air freely to the decomposing rock has maintained oxidation as one of the ruling chemical processes.

The other principal chemical process at work on the mineral matter of these soils is governed by the three conditions of (*a*) high rainfall fully absorbed, (*b*) free drainage, and (*c*) moderately high and equable temperature. It is a hydrolysis by water containing carbonic acid, with removal of the soluble products—or such of them as are not intercepted by tree roots—into the deep subsoil and so into the streams. The residual insoluble products, apart from quartz and resistant minerals such as magnetite, consist largely of free sesquioxides (hydrated ferric oxide and alumina). The bases, lime, soda and potash, are dissolved at an early stage, ferrous iron is dissolved, oxidized and reprecipitated, and the magnesium-aluminosilicate residual crystal-lattice, which in other circumstances forms what we call *clay*, is broken down so that the magnesia and silica are lost in solution and only the alumina is left. This last process is known as *laterization*, and the Usambara forest soils are therefore classified as "laterized red earths," the group shown by an orange colouring on the East African soil map [15].

Carried to an extreme, the laterizing process results in very infertile soils almost devoid of absorptive properties and very poor in the basic elements of plant nutrition. The Usambara soils have all gone a good way in this direction in the long course of their development under a wet climate, though of course there is variation from place to place. Some true clay remains, and still holds a small proportion of bases, though not enough to prevent the whole from being acid, as it always is. In so far as laterization is incomplete, the soil remains a hopeful medium for agriculture and will reward good husbandry.

The stage that has been reached can be roughly gauged by an analysis of the whole substance of the soil after removing primary residual quartz, which in practice means analysis of the finest fractions after a separation according to particle-sizes. The so-called clay fraction (it may or may not be true clay in the sense used above) then reflects in its composition the degree of accumulation of sesquioxides and of hydrolytic removal of silica. A soil is not regarded as laterized unless the "silica/sesquioxide ratio" falls below two molecular proportions of silica to one of sesquioxides. Thus many soils in which the chemical decompositions have been less severe, even some red earths, have ratios lying between 2 and 5, most commonly between 2 and 3. Soils of very advanced laterization, such as some that have been described in Mauritius, have the ratio brought well down towards zero. The status of the East Usambara red earths may be judged from the results of the examination of many samples from this point of view: the ratios lie between 1.2 and 0.75. The "younger" red earths of the steep escarpments give values about 1.6.

It is to be noted that the process of exhaustive leaching described above goes on throughout the substance of the smaller rotten-rock fragments that occur so numerously in the deeper subsoil, even while these still retain the semblance of their original gneissic structure. An appearance of rawness or immaturity, therefore, such as is often seen on eroded slopes where the rotten-rock gravel bulks considerably in the surface soil, does not indicate a superior fertility. It is only where *fresh* rock surfaces are contributing currently to the accumulating soil substance that the advantage of juvenility is realized. As already indicated in the paragraph on geology, this occurs on the tectonically-maintained fault scarps, and the effect is also seen locally amongst piles of fresh rock debris at the foot of perpendicular cliffs.

The sesquioxidic nature of the soils has effects on their consistence and structure, i.e. their properties of heaviness or lightness and their behaviour on wetting and drying. The ferric and aluminium oxides enter mainly into the finer particle-size groups, as they only locally, on ridge-top sites, acquire a concretionary habit as coarser aggregates. They do not, however, have the physical properties of cohesion, swelling and shrinkage that are possessed by true clay, or not to nearly the same degree. Thus, though a chemical analysis may show up to 40 per cent of "clay", i.e. of the finest fractions, the soil in cultivation is not correspondingly heavy as a farmer understands that term. These soils are in fact light loams; they drain freely, are readily friable wet or dry, and possess a uniform porous structure which seldom develops the columnar cracking that characterizes heavy soils during dry weather. The tendency to crack is there, and is seen for example on a hardbaked road surface, but the cracks do not open. A tilled topsoil dries quickly to a fine-granular state, yet the subsoil retains moisture well through drought, is easily wetted to depth by light rains, and is never waterlogged. Well-compacted earth roads are very durable, and if properly drained may truly be described as "all-weather."

Summarizing this part of the description briefly for the layman who may not have fully followed the technical argument, we have an old soil whose mineral skeleton has long been undergoing the chemical decompositions that are known as laterization, and which is therefore greatly impoverished in plant nutrients. It possesses poor powers of retention of the chemical bases against the washing-out action of percolating rainwater, and is acid at all depths. Its physical properties are, however, on the whole favourable.

The Organic Matters of the Soils

The organic matter profile under virgin forest is deceptive to the eye. The bright subsoil colours that have been described are encountered, only slightly shaded by grey, within a centimetre or two of the soil surface after scraping away the light covering of leaf litter. The "top soil" is thus not marked by any definite dark-coloured humic horizon. The observer's impression is that the organic content of the soil is quite low. Analysis shows, however, that the top 10 cm. has about 4 per cent of organic carbon, diminishing by a steady gradient to about 1 per cent at from 25 to 50 cm., and thereafter remaining at this value into the deep subsoil. The nitrogen content also is unexpectedly high, being proportional to the carbon content at a ratio C : N of about 12-15 : 1 independently of depth. Except for the not-yet-decomposed organic remains that lie on the soil surface as a thin skin, the humus, if we may call it such, is in a nearly colourless form. Under the acid but highly oxidizing conditions of these soils, black humus of the familiar kind does not form.

The pale humus has not much binding or crumb-forming power, but it confers a moderately high base-exchange capacity, up to 20 milligram-equivalents per cent, on the top spit of the soil in which it is mostly present. An important point, however—and this was a conclusion reached by Eichinger by simple analytical methods and some good thinking twenty years ago, and developed in the papers already referred to—is that the humus, considered as an acid base-exchange complex, is highly unsaturated, i.e. is an acid not much neutralized by bases, and so does not break down normally under the influence of soil bacteria. One effect of this is that the nitrogen it contains in considerable quantity, the amount of which deceived the early analysts into thinking that nitrogen should here never be a limiting factor to crops, does not become available in the season's cycle of decompositions, and the soils do in fact, at least with annual crops, respond markedly to nitrogen. Another effect is that the soil is fairly acid, often very acid, not only at depth, but also right to the surface. Still a third effect is seen by combining the conclusions about the nature of the "clay" substance with this about the nature of the organic substance: a laterized soil depends largely on the organic matter it contains for such base-absorptive power as it possesses, for the mineral colloids are for the most part non-clay in the true sense, and have little base-exchange capacity of their own. If then we lose in cultivation that topmost 10 to 25 centimetres of surface soil, we have lost the part that is the principal seat of the soil's give-and-take activities.

The top soils of the 35- to 45-year-old clearings have in fact a markedly lower content of organic carbon, of the order of 2.5 per cent. This represents the balance achieved between loss of the original forest-floor soil and recovery due to constant accessions of decaying residues of short-lived herbs and grasses, which tend naturally to make luxuriant growth as soon as the heavy shade of the forest has been removed. Here their growth was long kept in check by the tillage operations designed to keep the coffee land clean. Only when the period of neglect and abandonment began could the recovery make headway, for the management of the coffee lands under the non-intensive policy that was for the most part persisted in did not provide artificial replenishment.

The Relation of the Soil to the Forest

We now come to the apparent paradox that, on soils so fundamentally poor, so magnificent a forest was found maintaining itself. This also was a problem on which Eichinger had reached a conclusion, and his views agree with those now generally accepted. The same conclusion has been admirably set forth recently by another German worker, Walter [17], who studied this forest during a period of residence at Amani in 1934. In regard to West Indian forests it has been reached also by Hardy [18], and there are other demonstrations of it in the literature of forest soils, both tropical and temperate.

The high forest grew up along with the soil that nourished it. In the old age of the soil, when the original stores of plant nutrients that the parent rocks contained have been nearly all unlocked and those that the forest did not take have gone in the drainages of thousands of years, the trees depend for their maintenance on a nearly self-contained circulation of plant nutrient elements via fallen leaves and branches and trunks, through the micro-organic intermediaries of decomposition, the leaching waters, the feeding roots and the stems, and so to the leaves and branches again. Very large mobile stocks of the bases, phosphorus, sulphur, the minor elements and nitrogen are contained

in the substance of the living forest, which by this means now holds its own against the leaching process. The smallness of the further annual losses by drainage at the present stage of the partnership has been demonstrated by analysis of the stream waters of Usambara: they have a very low content of electrolytes. The forest, admittedly dependent on a high rainfall and humidity, thus comes to depend very little on further material supplies from the reserves of the soil. Its luxuriance is no trustworthy index to the degree of fertility that awaits the agriculturist for his own very different cropping system.

The Effects of Clear-felling and Cultivating

Now comes the act of clearing, followed by burning and tillage. The entire mobile stocks are put into liquidation, and, as is usual at a forced sale, they go at give-away prices and the advantage reaped is nothing like commensurate with their value. It was on what could be recovered of this hastily realized capital that the plantations gave their early promise.

A new circulation was, it is true, substituted, namely that set up in the crop trees, at a later date in the shade trees, and in the growth of weed and bracken that came in, at first vigorously. But the current funds thus kept in the business were of an altogether smaller order of magnitude. Value was taken out annually in the crop, and until the need was realized later, nothing was added to replace it. In the meantime the leaching process went on, and the excess of ash-constituents from the burning of the forest, beyond what could be taken up by the absorptive power of the humus layer, was lost into the streams. It is pretty certain also that the humus layer itself, so enriched, was lost too, partly by quickened oxidation encouraged by tillage and by the presence of bases from the wood-ash, and partly by soil creep and bodily shift down into the valleys; it is notorious that the African wielder of the hoe always turns his face to the slope and pulls each hoeful on top of him. Soon the unfortunate coffee felt the pinch, more especially as it had developed its system of feeding roots chiefly within the shallow layer of temporarily fertile topsoil [16]. The subsoil had little that it could draw on; favourable seasons stimulated it to heavy cropping and self-exhaustion followed by dieback; the somewhat warm climate (for Arabica coffee) gave pests an advantage, and in time the situation, as has since been proved, was irretrievable (Figs. 3, 4 and 5). On the most unfavourable sites even the weeds refused to go on growing luxuriantly and the abandoned clearings became poor grassland, yellow from some nutrient deficiency, possibly nitrogen or possibly a minor element. The less fundamentally infertile sites, though too poor to support economic coffee, began a slow return through secondary bush to forest.

The subject of "minor element deficiencies" has not been fully explored in regard to these soils, and it is not impossible that some unsuspected deficiency of this type has contributed to the failure of Arabica coffee in East Usambara. There is, however, no positive evidence pointing that way except the yellow colour noticeable in the grass and weeds of certain of the older clearings; and in view of what has been said of the genesis of the soils, and of their impoverishment since the forest was cut down, there seems no reason to look to such special deficiencies as playing a major part.

The Future with Other Crops

Here then we have soils now lying idle and awaiting the development of new crops or new methods to bring them again into productive use. Undoubtedly there are economically valuable plant species

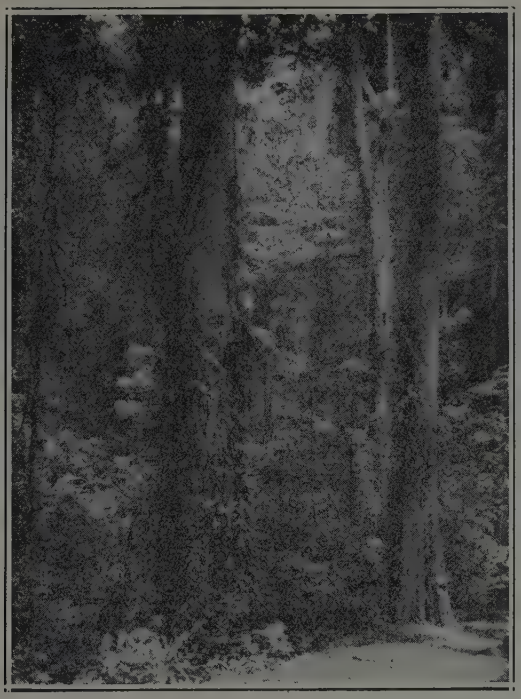


FIG. 2 [*Photo : P. J. Greenway*
Forest in East Usambara

FIG. 3 [*Photo : G. Milne*
Coffee 30–40 years old on typical slope under *Grevillea* shade
Untouched forest above, in background. East Usambara

FIG. 4
Typical coffee tree from site shown in Fig. 3

FIG. 5 [*Photo : R. F. W. Nichols*
Derelict coffee area, East Usambara ; forest in background. The site is more level than is usual, but is otherwise typical

that will tolerate the conditions better than Arabica coffee has done. The difficult problem to be faced is whether these soils, in the state in which we now find them or in any better state to which by reasonable means we can bring them, can support *a stable productive agriculture* under any crop or combination of crops that can be found.

It will be evident from what I have written above that, in my view, little can be expected of a further trial of "planting" of the kind that asks much and returns nothing. Some unexacting crop plant might it is true be found, under which the old circulating system of the forest would in some degree be restored, and from which a payable harvest could be won at intervals. Cinchona has in fact been regarded as likely to play this part successfully. It is not to be overlooked, however, that the mature cinchona plantations of the present day were the immediate successors of newly cleared forest, whereas for future plantings we have only the 35-40-year-old clearings. There is no question now of felling more of the high forest—only making the best possible use of ground already cleared. The old policy of large acreages handled extensively will have to give way sooner or later (in my view, best from the very outset) to one that provides for introducing fresh supplies into the circulatory system; for we have to compensate for heavy losses from it in the past, we expect to make periodic withdrawals in the crop, and we must recognize that whatever new system we set up will be inefficient and leaky compared with that of the virgin forest, so that losses of plant nutrients will be going on all the time through leaching and erosion.

On the methods of bringing in the additional supplies, there is some guidance from the known properties of the soils and from certain relevant details in the history of former attempts at better management in the later German period. The direct addition of artificials is not likely to be very useful. There are technical arguments against it based on the chemical and physical properties of the medium to which they would be applied, and there are difficulties in uniform distribution of fertilizers on rough land on which the employment of machinery is out of the question, particularly under permanent tree crops. Also artificials have frequently been tried in the past without visible result.

A more hopeful and probably sound policy is to make use of the fact, now established, that cattle will do reasonably well on the rough grazing afforded by much of the abandoned coffee land which still carries its old *Grevillea* shade. These grassy enclaves appear to be happily tick-free, and tsetse, though not quite absent, is negligible. Also other cleared hillsides, dropping down towards water and bordering tracks along which ox-carts can travel, carry a strong growth of grass and bracken that it is hoped will prove to be good composting material. Here are the elements for compost manufacture on the necessary considerable scale. The supplementary fertility needed can in large measure be won from land that there is no intention of using for *cash*-crop production, provided enough of such land is devoted to this purpose of helping to maintain a smaller acreage of adjacent land under the crop that is to bring in the income.

Much depends in this programme on the cost of compost-making under the given conditions, and on the economics of maintaining a cattle herd kept primarily for the sake of its manure. No doubt in time the increase of the herd will itself be a form of profitable production. The compost pits will be the ideal channel through which to introduce purchased nitrogen,

lime and other supplies. Much, too, depends on the suitability of the selected crops, whose sufficient response to intensive management is by no means to be assumed from our present knowledge. But there is at least a fair prospect that by such means as are now under test a proportion of the old clearings of East Usambara will again become agriculturally productive.

Summary

The history of Arabica coffee planting in forest clearings in East Usambara (Tanganyika Territory) is briefly sketched, from its beginning in 1891, through the decline of the plantations during the decade before the war, to their almost complete abandonment at the present day.

The soil (a laterized red earth on gneiss) is described in relation to the factors in its formation and particularly in its relation to the evergreen forest. The effects of clearing and of non-intensive plantation practice are traced, and the conclusion is drawn that the hope now being entertained of bringing the old coffee clearings again into production under other permanent crops depends for fulfilment on the adoption of intensive methods on small acreages.

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A Summary of the Meat and Live Stock Inquiry Committee Report, Kenya

The Committee, which consisted of the Hon. Attorney General (chairman), the Hon. Chief Native Commissioner, Major the Hon. H. H. Brassey-Edwards, O.B.E., R. Daubney, Esq., Capt. E. Caswell Long, Lt.-Col. G. C. Griffiths, C.M.G., J. J. Toogood, Esq., and H. B. Hamilton, Esq., was appointed in October, 1935, with the following terms of reference:—

" (i) To inquire into the possibility of introducing legislation in Kenya similar to that in existence in South Africa, with regard to the establishment of a Live Stock and Meat Industries Control Board, and to define its functions.

(ii) If legislation is considered feasible, to report on the existing condition of the live stock industry of the Colony and to formulate a scheme on the lines of legislation in South Africa.

(iii) To report similarly on the potential expansion of an export industry.

(iv) For the purpose of this inquiry, to take evidence from interested parties."

In the view of the Committee the legislation relating to the Live Stock and Meat Industries Control Board of South Africa had primarily been based upon the need to develop an export industry in meat, and it was at once decided that it would be useless to contemplate applying similar legislation in Kenya until it had been decided (*a*) whether the development of a meat export trade is essential to the success of the agricultural industry in Kenya, and (*b*) whether it is an economically practical proposition at this stage of the Colony's development. Accordingly the order of the main terms of reference was inverted, and the Committee first considered its third term of reference, relating to the potential expansion of the industry.

General Considerations

It is pointed out in the report that the trend of general farming practice in the settled areas of Kenya has changed considerably in recent years, and that the tendency to-day is towards the general adoption of mixed farming in areas that have for many years been devoted almost entirely to crop growing. This change is largely to be ascribed to the rapid progress made by the dairy industry during the last six years, and to the security enjoyed by owners of dairy herds during the recent period of acute financial depression; in consequence, the attention of farmers has been focussed more strongly upon the advantages offered by a balanced system of farming in which live stock plays its normal part. Reference is made to the persistence of the ranching method of dairying, which is practised on lands that are quite unsuited to dairying, but are of a type ideally suited to the raising of beef cattle; the reason being, of course, that while there is an unlimited export market for dairy produce, the beef market is strictly limited to the amount that can be consumed locally.

In a brief general review of conditions in the stock industry, the committee also draws attention to the fact that pig production has failed to keep pace with the expansion of the dairy industry; and in fact the ratio of numbers of pigs to numbers of dairy cows has broadened from 3.2 pigs to 10 cows in 1922, to 1.87 pigs to 10 cows in 1934, a figure which is very much below that of any other territory engaged in the export dairy industry. It is also remarked that up to the present time little

or no use has been made of small flocks of sheep in mixed farming operations. In both these instances it is the lack of an export market capable of absorbing any surplus over and above the requirements of the local market that has restricted the normal development of the industry. The absence of adequate markets for slaughter stock has also reacted unfavourably upon the economic development of the pastoral native reserves. It is estimated that these pastoral reserves produce a surplus of at least 120,000 head of cattle per annum over and above present slaughterings for the markets of the Colony; and it is pointed out that if only a reasonable proportion of these carcasses reaches, or can be made to reach, an exportable standard, the operation of a packing house can be conducted on a scale commensurate with economic efficiency. It is realized that many of the animals available from the overstocked or badly managed native reserves will only be fit for canning or extract purposes, but the removal to a canning factory of these lower grade animals would permit a general overhaul of grazing areas, the laying down of quotas of stock for the different sections of the reserves, and the initiation of comprehensive schemes of development for the pastoral tribes.

Reference is made to the report of the Agricultural Commission of 1929 under the chairmanship of Sir Daniel Hall, which recommended the establishment of meat-canning factories to deal with overstocking in certain of the reserves; and to the recent Colonial Development Fund grant of £23,500 for the erection and maintenance of a fertilizer factory at Eldolat. Final acceptance of this scheme was delayed, largely because the low price that it was proposed to pay for cattle—from Sh. 5 to Sh. 7 per head—seemed likely to create difficulties in the way of obtaining the necessary supplies. The committee considered that administrative officers would be reluctant to support any scheme which compelled the native to sell his stock for such an inadequate return. To some extent the situation has been relieved by four years of drought and a severe epizootic of rinderpest in the northern pastoral reserves; it is calculated that numbers in 1935 and 1936 were near the lowest point in the cycle, but as a result of exceptionally good calvings the process of building up has again begun.

The committee's recommendations on this particular issue read as follows:—

"After reviewing conditions generally in the live stock industry, and having regard more particularly to the needs of agriculture in the matter of development of the live stock side of the industry, and to the urgency of the need to find markets for native cattle, the Committee concludes that, not only is an export trade in meat essential if the agricultural industry of the Colony is to continue to evolve in a satisfactory manner, but that the development of such an export is vital to the survival of the industry in the settled areas."

Practicability of Export

Having satisfied itself of the fundamental importance to the Colony of a meat export trade, the committee turned to a consideration of the economic practicability of export under present conditions. The possibility of exporting live cattle on the hoof to neighbouring territories and to the Mediterranean area was examined and discounted on account of the nature of quarantine regulations against East African tropical diseases. It remained to consider what the prospects were of developing an export trade in canned meat and/or frozen and chilled meat to Great Britain, and more particularly the London market.

It is to be remarked that during this phase of its proceedings the deliberations of the committee were largely confined to an examination of questions concerning

the export of beef, since it was felt that in the long run it was upon beef that an export trade must be based, and that frozen pork, fat lambs, and poultry must be considered for purposes of factory operation as merely representing sidelines. The secretary was permitted to visit Southern Rhodesia to examine the canning, freezing and chilling plants in that territory, and to study the methods by which supplies are made available. Arising out of that visit, Messrs. Liebig's (Rhodesia) Limited sent two representatives to the Colony in 1936 to report on the suitability of Kenya conditions for meat canning operations.

Canning Factory

Meanwhile the committee had given careful consideration to such matters as the probable size of the annual surplus available for a canning factory (which was estimated at not less than 120,000 head), the prices that would be acceptable to the native, and to the administration, and the possibility of effecting the necessary large-scale movements of cattle from the selected areas to the factory without endangering the health of cattle in the settled areas and the unquarantined native reserves. The Liebig representatives satisfied themselves that there were good prospects of success for a canning factory with a minimum capacity of 30,000 head of cattle per annum, and eventually the company entered into direct negotiation with Government and an agreement was signed in December, 1936. As soon as it became evident that an agreement was likely to be reached, the committee took the opportunity to impress upon Government the need for the organization of stock routes, dips and water supplies to facilitate movement of cattle under adequate veterinary supervision from the reserves to the factory.

Chilled and Frozen Beef

Turning next to the problem of export of chilled and/or frozen beef, the committee had before them for examination extensive data collected by the secretary during a visit to the United States, and figures relating to the actual weights of Kenya cattle gathered by Dr. M. H. French during a stay in Nairobi. The conclusion reached by the committee was that no difficulty should be experienced in arranging for a supply of 50,000 head per annum for a freezing and chilling plant, provided adequate notice is given to the industry of the intention to begin operations on a certain date. On the question of quality, Dr. French's figures and other figures obtained by the committee indicate that very little is needed to raise cattle in the settled areas to export chilled beef standard; and a point is made of the manner in which cattle in Kenya, with its two rainy seasons, maintain satisfactory condition throughout the year.

The committee's conclusions were largely confirmed by Mr. G. E. L. Straith, the General Manager of the Rhodesian Cold Storage Company, Limited, who visited the Colony during the session of the committee. Mr. Straith considered the native stock of the Colony good, and he stated that he had seen cattle in the settled areas, three years old, that were fit for export as chilled beef to-day. These cattle were taken directly off grass, and it would be quite impossible to produce animals of this weight and in this condition in Southern Rhodesia without heavy supplementary feeding. Of the native cattle, Mr. Straith considered that the Samburu represented a very high standard indeed, and many of them were fit for export as chilled beef to industrial centres, such as Bristol, Birmingham and Liverpool. It was Mr. Straith's view that it should be the aim in Kenya to enter the highest class of meat

export trade, that is, the chilled meat trade of the London market. He saw no reason why Kenya should not compete, and compete successfully, with the Argentine.

The Chief Veterinary Research Officer discussed with the committee tentative plans for the development of the better pastoral areas, and in particular of the Western Masai Reserve. He has imported a number of pure-bred beef bulls, which are to be used in a crossing experiment with native cows with the object of carrying out a comparative beef test on cross-bred and native animals. The Chief Veterinary Research Officer shares with Mr. Brinton and Mr. Straith the opinion that the western section of the Masai Reserve is excellent ranching country; and that under a suitable programme of development, which will include the provision of water supplies and the conservation of fodder for the dry periods, this area is capable of producing large numbers of cattle of chiller quality, which at the age of from two to three years should be bought for finishing by feeders in the more fertile areas. The committee strongly supports this project to develop the pastoral areas, and recommends that Government should give every facility for the initial experimental work with a view to the practical application of the plan on a large scale.

Having examined the evidence at its disposal, the committee was convinced that there are very real possibilities for the immediate organization of an export trade in cold-stored meat and meat products. Its findings on these points were conveyed immediately to Government, and they included a recommendation that Government should become a shareholder in the proposed cold storage company, if necessary on a pound for pound basis, with the Imperial Cold Storage Company. These recommendations provided the basis for further discussions between Government and the Imperial Cold Storage Company, Limited, of South Africa, which are not yet closed.

The Pig Industry

The committee draws attention to the position of the pig industry, which has remained static in spite of the progress made by the dairy industry, to which it should largely be complementary. The views of pig producers on various proposals were ascertained by circulating a questionnaire, and there was almost unanimous agreement that an attempt should be made to create an export for frozen pork, and to effect some form of equalization of the returns derived from sales on the local market and sales by export.

It is the view of the committee that the export of frozen pork can best be carried out from a large factory operating on all classes of cold-stored produce, and that an attempt should be made to begin with an export of at least 5,000 pigs per annum in order to maintain steady supplies on the London market.

Sheep

Having examined the available evidence, the committee concluded that there was every reason to believe that a profitable trade in exportable fat lambs could be established in the Colony. The Chief Veterinary Research Officer is at present engaged in crossing experiments with Southdown rams on Merino, Romney Marsh and native ewes. The committee was strongly of opinion that this experimental work should be supported by Government, and that if necessary special facilities should be accorded to the Veterinary Research Laboratory to continue this investigation until it is brought to the commercial stage. In view of the value of the flying flock to the mixed farmer in maintaining the fertility of his soil, and in

providing him with a profitable side-line, it is recommended that every effort should be made to encourage this particular branch of the industry. The committee also referred to the rapidly increasing export of eggs, and suggested that frozen dressed poultry might also be handled by the export house.

First Term of Reference: Live Stock Legislation

Having decided that the provision of export markets for meat does not offer any insuperable difficulty, the committee proceeded to consider legislation directed to the development of the meat industry. It was pointed out to the committee that the Nairobi market, and other large urban markets, had in the past been largely protected from flooding by the existence of veterinary quarantine regulations which had the effect of blockading certain of the native reserves. If the industry were to develop normally, a much wider freedom of movement would be essential. The first step towards obtaining this freedom of movement had already been made in the Samburu Reserve, and immediately the Liebig factory opened, it would be necessary to authorize extensive movements of cattle to the factory. If the Nairobi market were not to be flooded as soon as these additional sources of supply became available, it would be necessary to exercise some control of supplies, and the committee recommends the establishment of a Meat Control Board, one of whose functions shall be the control of supplies to the internal markets. Once an export trade has been started it may be necessary to effect some form of pool of returns from export and domestic sales to ensure that cattle of the best quality are brought forward for export. The Meat Control Board would undertake this task, and also that of supervising the final grading of meat on the Nairobi and other large markets.

With regard to the export of pigs, it is suggested that the Board should be empowered to impose a cess or levy on local sales of slaughter pigs, and to apply the funds accruing from this levy to bountifying sales for export or sales of surplus pigs made during the period of preparation.

The functions of the Meat Control Board in respect of pigs, sheep and cattle should be exercised by sub-committees of the main board, formed to deal with these particular branches of the industry.

Live Stock Improvement

It is suggested that in its capacity as an advisory body the Meat Control Board should advise Government on measures relating to the improvement of live stock as a means of furthering the development of the industry, with particular reference to the export trade. It is pointed out that there are in the country to-day neither sufficient breeding cattle of the correct beef type, nor sufficient breeding pigs to ensure a rapid multiplication of a type suited to the export trade, and this statement applies equally to rams of the breed required for the fat lamb trade. The committee therefore recommends that "as part of the programme of development a sum of, say, £3,000 per annum should be set aside for the purpose of providing assistance to approved farmers to purchase pure-bred breeding stock, preferably males. Grants should not exceed in amount half the landed cost of the animal at the purchaser's farm, and in the case of animals imported from overseas should not exceed £50 for each bull, and £20 for a boar or ram; in the case of animals purchased locally the maxima of the grants should not exceed £25 and £5 respectively. Farmers should be invited to submit during a specified period each year applications for assistance from the fund, and grants should then be allocated for the

year after an examination of the applications. The initial allocation of the funds as between cattle, pigs and sheep, might be decided by the Meat Control Board, who should be in the best position to judge the relative needs of each branch of the industry."

The report runs to 110 pages, of which approximately half are taken up by the various appendices; the latter may be regarded as the framework of the evidence on which the report proper is based. It is published by the Government Printer, Nairobi, Kenya Colony; price Sh. 3/25 (including postage).

R. D.

The Composting of Sisal Waste

By S. C. LAYZELL, *M.C., Estates Manager, Taveta Estates.*

If the managers or owners of the majority of sisal estates in Kenya and Tanganyika are asked what is their greatest bugbear, in nine cases out of ten the answer will be "the disposal of waste". You will find that great pains are taken to have the factory sited near some ravine or hollow in which the "horrible stuff" can be dumped, or near some delightful stream into which the waste can be led (with the hope of a flood removing it some time or other), to the complete destruction of the stream's inhabitants and to the offence of the olfactory senses of all the residents within miles. It is on account of such methods of waste disposal that the average sisal factory is a most depressing and nauseous spot.

The water supply to sisal factories is usually an expensive undertaking, often comprising the sinking of wells or boreholes, the making of dams or reservoirs, the installation of pumping plants and power units, the cry being that one must have a sufficient water supply, not only for washing the fibre and cooling the engines, but also for getting rid of the waste. A good part of the expense, therefore, involved in the installation and maintenance of an efficient water supply is for the purpose of filling some depression in Africa with an inert, anaerobic, stinking mass or of polluting some inoffensive stream.

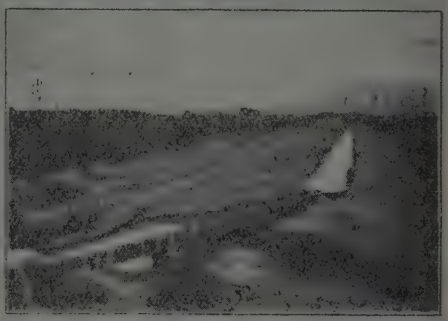
For many years Sir Albert Howard, C.I.E., M.A., has been engaged in conducting a vast field of experiments in the composting of various waste products, and has given us a great deal of valuable literature on the subject. At the same time, valuable work has been done in the coffee areas of Kenya, e.g. on Major Grogan's coffee estate at Kingatori, where a well-organized system is being worked with admirable results by Major Belcher, his manager.

The composting of sisal waste on Major Grogan's estate at Taveta, after conversations and correspondence with Sir Albert Howard, absorbed our attention in 1935. The objects aimed at were (*a*) the use of the liquid part of the waste for irrigation of crops; (*b*) the conversion of the solid residue into humus by composting.

In order to attain these ends it is desirable to have a sufficiently large area in the neighbourhood of the factory (*a*) where the water can be put to good use for irrigation purposes; (*b*) for a composting ground.

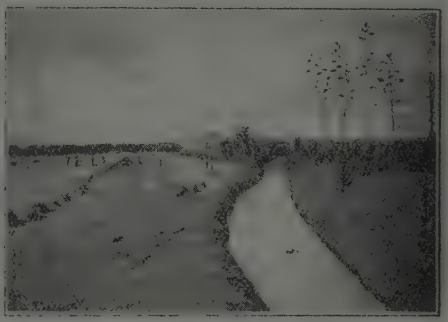
The first problem is the satisfactory separation of the liquid from the solids in the flume waste. At Taveta all the waste from the decorticator is passed over a grid at the end of the flume. This grid holds the solids and allows the liquid to pass into a concrete sump beneath. From this sump

Grid at end of flume separating the solids from the soup



Flume for soup and rail for solids side by side

Draining (the trucks are slatted)



The soup flume with spread waste and first and second turned heaps

The composting area: note sisal poles in the background on to which the first spread is made

Spreading

the irrigation flume runs, and the liquid flows quite satisfactorily at a fall of 1 in 1,000. The slats of the grid are made of 1 in. galvanized piping and run the same way as the flume, not across it, and are spaced two inches apart, the width of the grid being the same as the flume.

From the grid the railway system leads to the composting ground, and is arranged with the usual crossings and loops to allow of the marshalling of the empty trucks. The collecting truck is the usual four-wheel frame, constructed of timber, on which rests a platform of wooden slats. The slats are at right angles to the track. This allows the heaped waste to be raked off with ease from either side. The truck is placed in position at the end of the grid and the solid waste raked off the grid on to the slatted platform; when fully loaded it is wheeled far enough away to make space for the next truck, and allowed to stand and drain over a concrete basin until it has to move on to make room for the next loaded truck. The drainage water from the basin is led into a smaller irrigation furrow, and is also utilized. The number of trucks required depends on the distance between the grid and the composting ground.

The lay-out of the composting ground requires careful preparation. Sisal poles in groups of four, equally spaced, are first laid out on the ground on both sides of and at right angles to the rail track. The reason for this sisal pole foundation is to promote aeration from below. The poles are spaced a foot apart, so that the heaps have a foundation of 15 ft. x 4 ft. The waste from the trucks is spread on this foundation to a height of two feet. This is the first stage. Sufficient space must be left behind these first-stage heaps to allow of two turnings, and if possible three or four. The waste is left on the poles for thirty days, and it is in this period that the greatest fermentation takes place, it being impossible to bear one's hand in the heap.

The first turn then takes place, the waste from two sets of heaps on poles being turned backwards into one heap. This is possible as the bulk has already considerably decreased. This second stage lasts for another thirty days. It is in this stage that the growth of fungi is most noticeable. In the morning the whole heap is often covered with a dark long-stemmed fungus. (Probably the heaps at this stage would grow good mushrooms.)

The second turn then takes place, that is to say, sixty days from the time the waste was first delivered on to the poles, and is allowed to remain for another thirty to forty days, when the process is complete and the compost, which now resembles very lovely leaf mould, is ready for its return to the land as valuable humus.

As new heaps require a "starter", a planter inaugurating this system should obtain for the purpose a little mature compost from another estate or farm. A few handfuls of old compost, distributed evenly in the heaps, is sufficient to start fermentation.

The aeration of the compost can be improved by the insertion of layers of elephant grass in the first heaps, but I have not found this to be essential.

The composition of the finished compost, as shown by analysis, is as follows:

Carbon: 23 per cent.
Nitrogen: 1.44 per cent.
C/N ratio: 16.
Acid soluble ash: 15.3 per cent.
Reaction: pH 8.5 per cent.

The value of the compost as a fertilizer on its constituents has been given me as Sh. 40 per ton.

With regard to costs, the actual number of men employed on turning the heaps,

dealing with waste from a decorticator producing 150 tons of fibre per month, is 34 (at Sh. 5 a month plus *posho*) and two headmen. The number employed on the grid and the trucks is dependent on the distance of the composting ground from the grid. In our case the number is 16 men.

The grid system could, I consider, be improved upon by the substitution of a slotted elevator which would allow the liquid to drain through and run back into the sump, and at the same time would discharge the solids on to the waiting trucks.

The employment of a flume tow waste recovery plant, a number of which, I understand, are now being installed in Kenya, should greatly assist the work of composting, as it is the fibres in the waste matter which take the longest time to break down in the heaps. If these fibres were removed by the waste recovery plant, the remaining solids could be more easily dealt with. Probably these solids could be water-borne and the truck and rail system eliminated. If such proves to be the case the whole of the present method will be greatly modified. Further experimental work would, however, have to be carried out in this direction.

With regard to the flume liquid, we are now using it most successfully for irrigating sisal nurseries, bananas, ginger, maize, sugar cane, citrus, lemon grass, and potatoes.

The main use of the flume-water irrigation scheme at Taveta is to grow a variety of native food crops to augment the usual set ration of mealie-meal, beans and salt. The psychological effect on the native of seeing a large area of bananas, sugar cane, citrus trees, and potatoes which he knows are being grown for his benefit cannot be over-estimated, as the always present fear at the back of his mind is the possible lack of food for himself and his family.

These food areas are proving a great attraction to labour, and, needless to say, are of great benefit to their health and physical fitness.

The compost itself we are using for application to citrus, avocado pears, pineapples, grape-vines, and vegetables; also it is being gradually returned to the sisal fields.

When one realizes that sisal ranks high (if not the highest after pineapples) in the plant world as a depleter of the soil, is not the trouble and the small expense involved in making the compost and then returning it to the land, by means of the empty leaf trolleys, worth while? If this is done systematically we can eventually leave the land in not merely as good a condition of fertility as we found it but possibly better. Moreover, our repulsive rubbish dumps will be things of the past and our factory compounds attractive in appearance and wholesome in smell.

Beekeeping for Beginners—Part I

By W. VICTOR HARRIS, *M.Sc., F.R.E.S., F.Z.S., Entomologist, Department of Agriculture, Tanganyika Territory.*

INTRODUCTION

Beekeeping, as a hobby or as a subsidiary occupation for the farmer, may be carried out successfully in East Africa. Except in limited areas, which will be discussed later, reasonable yields of good honey can be obtained, for which a local market can be found without difficulty.

The East African honey bee, *Apis adansoni*, is not so tractable as its European relation, but this is not surprising when one considers the number of enemies it has, and how the European bee has not only been domesticated for centuries but has during that time been selected for docility among other desirable traits. As a result, many of the more interesting manipulations of the colony in Europe, such as queen rearing and the various methods of swarm control, or even the regular opening up of the hive "just to see what is going on," have become rather difficult and much more hazardous in East Africa. Left undisturbed however, *Apis adansoni* behaves well and adapts itself to the conditions imposed by a frame hive and European ideas of beekeeping.

There are three races of our local honey bee, the commonest, *adansoni*, having a yellow and black striped abdomen, rather like the Italian bee, but slightly smaller. The other varieties both have the abdomen black, the one called *unicolor* being smooth, the other *intermissa* having bands of paler hairs between the segments. The black bees appear to be restricted to areas over 3,000 feet in elevation, only becoming numerous, in the writer's experience, over 4,000 feet. All three races can exist in one area. The *adansoni*, with black and yellow abdomen, though fierce at low elevations, becomes much easier to handle in the cooler upland areas, and is to be preferred to either of the black bees.

MAKING A START

The first thing the beginner requires is a hive. Now a moment's consideration of the conditions under which bees live in the wild state will show that an elaborate frame hive with a multitude of gadgets is not essential, either to the vigour of the colony or to the flavour of the honey produced. One of the largest apiaries the writer has visited in Tanganyika consisted of some forty or fifty colonies housed in hollow log hives of the native pattern, from which the farmer obtained a profitable return of good quality honey. However, this system was, to say the least, primitive, and not what is usually understood as beekeeping. Log hives are difficult to handle, and the danger of driving away the bees when taking out honey is great, so that one always has an unnecessarily large proportion of empty hives.

Petrol cases can be adapted with little trouble to form simple hives which are an improvement on the hollow log. The back is removed and the boards strengthened with battens at each end. It is then fastened on again with four large-headed screws to the thicker wood of the box ends. Three entrance holes, half an inch in diameter, are bored at the bottom of the opposite face of the box, just clear of the bottom boards, one in the middle, the others near the sides. Then a piece of wood is nailed to the bottom of the box, to project two inches from the front, in order to provide a place on which the bees alight before entering the hive. The whole exterior is then well coated with white paint or, failing this, creosote. Such a hive will

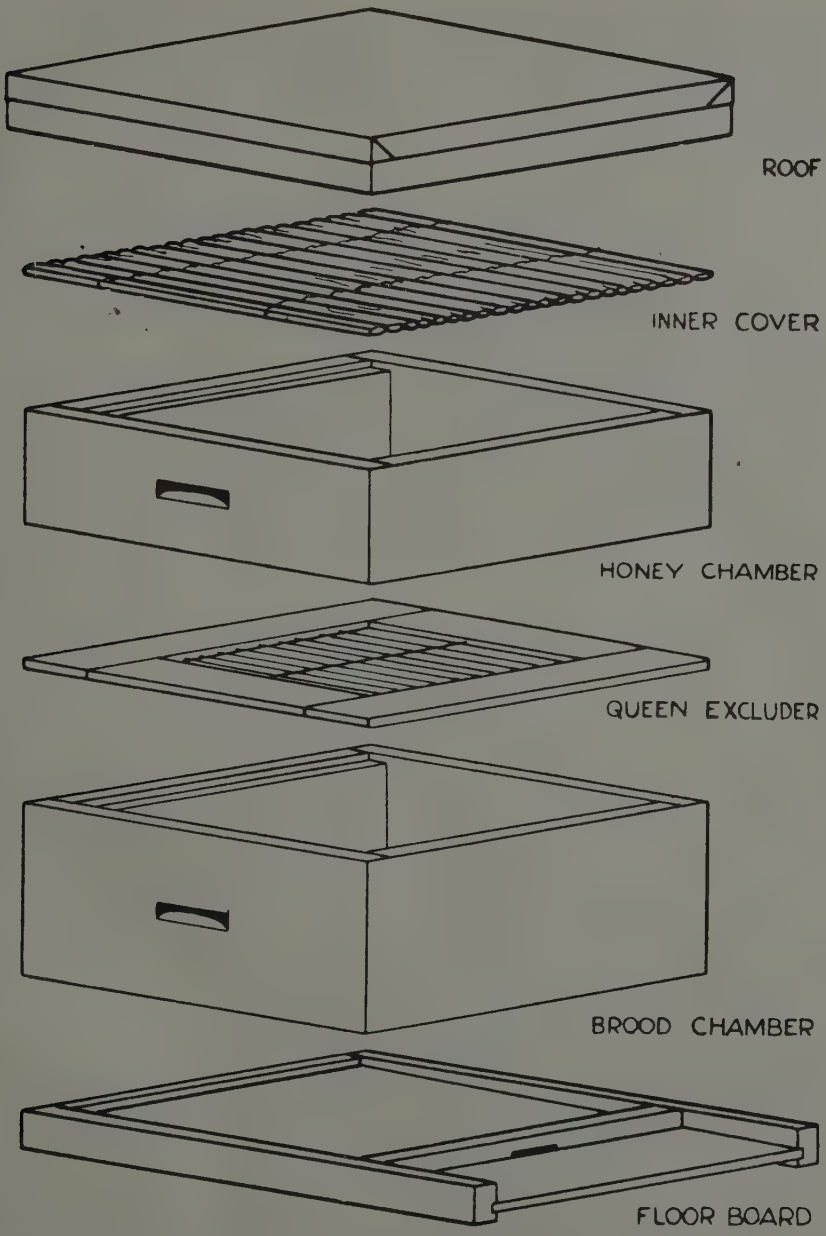


FIG. 1

Beehive of single walled American pattern to take British Standard frames

last many years if protected from the weather by a grass-roofed shelter, particularly if covered over with a piece of asbestos sheeting or wooden board projecting at least three inches all round. The screws are taken out and the back is removed when it is desired to obtain honey comb.

To keep bees, however, in the sense that one purposely directs their activities towards the production of an easily available surplus of honey, and with due regard to restriction of swarming and the continued life of the colony, requires a frame hive of the modern type. The essential feature of this is that the sections of comb comprising the nest are built within movable frames, which may be removed from the hive or rearranged as becomes necessary. The invention of new types of frame hives still proceeds. The dimensions of the hives and their component frames vary considerably, but in English-speaking countries follow two main lines, the British Standard and the American, the main difference between these being that the British frames are slightly smaller than the American.

As the bee is an accurate builder himself, the wise beekeeper will follow in the same path with his hive construction. To follow accurately the dimensions of one of the standard pattern hives will ensure that the parts of the hive are interchangeable amongst themselves and with any hives that may be purchased. Details are given here of one type only of beehive, a single-walled pattern with British standard frames, adopted two years ago as the National Single-walled Beehive by the Ministry of Agriculture and Fisheries, London, and used successfully by the writer for a number of years. This hive consists of three main parts, viz. a floor board, a body or main chamber in which the bees live and rear their brood, and a roof. To these is added a super or honey chamber, once the colony is established, to accommodate the stores of honey. Such a hive may be purchased for Sh. 24 in England, ready for nailing together. (Fig. 1.)

Making a Hive

(1) The floor board consists of a rectangle 18 inches wide by 23 inches long, made of two long sides of $\frac{3}{4}$ in. wood grooved to take $\frac{1}{2}$ in. boards. The grooves are sloped so that the bottom boards run from half an inch below the side pieces at the back to one inch at the front. The rim is completed at the back by a piece of $\frac{7}{8}$ in. by $\frac{1}{2}$ in. wood nailed across the floor.

(2) The brood chamber is 18 in. square and $8\frac{3}{4}$ in. deep. Two sides are made of $\frac{1}{2}$ in. wood with an internal wall fitted in grooves up to half an inch from the top to provide ledges $1\frac{1}{4}$ in. wide on which the lugs of the frames rest. The spaces between the double walls are enclosed by pieces of thin wood top and bottom, and are usefully filled with celotex or other insulating material. (Fig. 2.) The other two walls are made of $\frac{3}{4}$ in. timber.

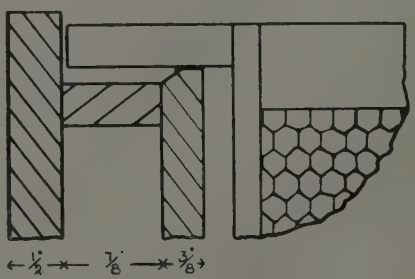


Fig. 2
Detail of chamber to show ledge for supporting frame. Note projecting inner wall to reduce gumming of frames to hive wall by bees

(3) The super or honey chamber is similar to the brood chamber, except that it is only $5\frac{3}{4}$ in. deep.

(4) The roof is made to fit easily over the super, with a projecting rim of 3 in.

Using $\frac{3}{4}$ in. timber, its external dimensions will be $19\frac{3}{4}$ in. square and 3 in. deep. It should be covered with galvanized iron or preferably roofing felt or asbestos sheeting to render it weatherproof.

(5) The entrance block is a piece of wood, $\frac{7}{8}$ in. square in cross section, cut to fit firmly in the baseboard beneath the front edge of the brood chamber. An opening $\frac{3}{8}$ in. high and 4 in. long is cut out to provide an entrance for the bees into the hive.

All timber should be well seasoned, and dovetailed points are recommended. The whole hive now requires to be painted white, two coats outside and one inside. This adds considerably to its life, helps to keep down the temperature inside, and, provided the paint is renewed at intervals, improves its appearance. The hive is now complete except for—

Hive Fittings

Frames.—The two chambers of the hive now require to be fitted with frames. While these may be made on the farm, they are generally purchased ready cut, as the price (approximately Sh. 12 for 50 in England) is low, and the frames are more likely to conform to standard. It should always be remembered that in ordering frames, the type of hive used, Langstroth, British Standard, etc., must be clearly stated. The British Standard brood frame is 14 in. by $8\frac{1}{2}$ in., with the top bar projecting $1\frac{1}{2}$ in. on each side to rest on the ledges formed by the double walls. The shallow frame for the honey chamber is $5\frac{1}{2}$ in. deep. The top bar of the frame is $\frac{7}{8}$ in. wide. In order to ensure the correct spacing of the combs, either the ends of the top bar are made wider or, better still, metal ends are fitted, 1 9/20th in. in the case of brood frames and $1\frac{3}{4}$ in. for shallow frames. (Fig. 3.)

The brood chamber can accommodate eleven frames so placed, but ten are usually employed, the remaining space being filled up by a dummy, a piece of wood cut to the size of a frame and hung at one end. The dummy is removed first when the frames are to be examined, thus

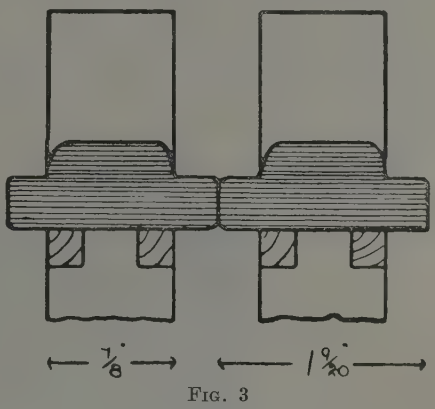


Fig. 3

Detail of frame ends to show spacing with metal ends

leaving sufficient space for sliding the frames about. The super takes nine frames at the wider spacing.

Foundation Comb.—In order to ensure that the bees build along the right lines, and to reduce the time and material used by the bees in producing wax for comb at the expense of honey production, the frames are fitted with thin sheets of wax on which are embossed the pattern of the cells. This wax or foundation comb is rapidly drawn out into full-sized comb by the worker bees with the addition of any small amount of wax necessary. Foundation comb is purchased ready made, or can be made at home with a special rolling machine or in moulds. In the tropics, the use of foundation comb strengthened with wire is necessary if accidents due to sagging are to be avoided. Here again, ready-wired foundation may be purchased, or the wiring done by the beekeeper. A full sheet of wired foundation is used for the brood frame. Short strips of foundation

may be used as starters in super frames, but if the honey is to be removed in an extractor and the empty comb returned to the hive for further use, full sheets of wired foundation are necessary to stand the strain. The foundation comb is fixed in the frame in a variety of ways, one of the simplest being to have a groove in the top bar into which the comb fits, with molten wax run in to hold it in position. (Fig. 4.)

Queen Excluder.—To prevent the passage of the queen from the brood chamber up into the super, and so to avoid the occurrence of brood among the honeycomb and any possible disorganization of the colony, it is usual to place a queen excluder on top of the brood chamber. This consists of a wooden frame exactly the external dimensions of the hive body, i.e. 18 in., in which is fitted a wire grill, so made that the spaces between the wires permit of the passage of the worker bees but stop the larger queen. Queen excluders of perforated metal are more likely to interfere with the proper ventilation of the hive.

Inner Cover.—The upper chamber is covered with a quilt which prevents the bees from building up against the roof, and so making opening difficult. A piece of fine grass matting is recommended, as it can be rolled up gently when the hive is open for inspection, and it also ensures a certain amount of top ventilation when the hive is closed. Wooden covers have to be removed bodily and are less easily detached.

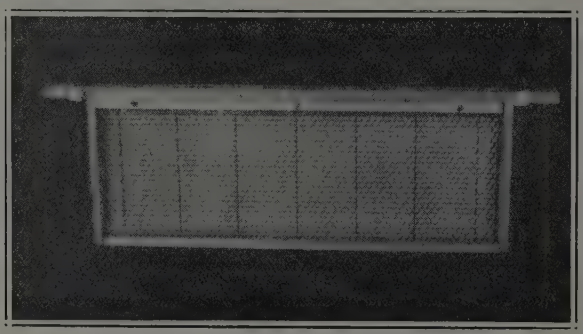


FIG 4
Shallow frame fitted with wired foundation wax, and metal ends, ready for the hive

ASSEMBLING THE HIVE

At first, only the brood chamber will be required to accommodate a new colony in the hive, so that when ten large frames have been prepared with foundation wax, and fitted in, the hive is ready. The brood chamber is placed on the floor board so that the back and sides are flush with the edges. The entrance block is then fitted into the gap between the floor board and the front of the chamber, thus limiting the space allowed for entrance into the hive. The orientation of the chambers, so that the frames lie in a particular direction with respect to the entrance, is a matter more of theoretical than of practical importance. As both super and brood chambers should lie the same way, it makes for easy working in the apiary if one way is adopted throughout, and as ventilation is said to be easier when the frames lie at right angles to the entrance block, this way is recommended.

The brood chamber is then covered with the inner cover, which should be carefully cut to fit, and finally the roof is placed in position.

A stand for the hive is necessary, as the model described here does not incorporate legs. The type shown in Fig. 5 is easy to make and renders the hive proof against termites, ants, lizards and toads. Four cement blocks of the type commonly used for boundary marks are cast with pieces of 2 in. by 1 in. ant-resistant timber fitted into the top and projecting three inches. Four pieces of tin about nine inches square are cut with holes to fit tightly over the wood (the tops of petrol tins are handy for this purpose). The blocks are placed on the ground to support the four corners of the floor board so that the hive rests quite level. A further improvement is to fit cross-pieces to the tops of the stands to make a permanent platform from which the hive is less likely to slip.

FIG. 5

Beehive assembled and placed in position on insect-proof stand. The extra deep roof of this hive covers the super

In choosing a site for the beehives, attention should be paid to shelter from the wind, shade from the afternoon sun, and proximity to water. Trouble is avoided if the site is well removed from farm buildings generally, as bees are hasty-tempered at swarming time and liable to resent the movement of people and animals, and particularly such noises as are made by lawn mowers in operation. Do not place the hives with their backs close to a wall or hedge, as there will be no room to work in when the time comes to open the hives. If a number of hives are being erected, it is better that they should not be placed in a straight line, close to one another. Bees recognize their homes by sight, and an irregular arrangement of the hives assists them in getting their bearings. Above all, remember that the bees are busy, and that the less they are disturbed by their enemies, natural or unnatural, the more work they will do, and the more honey will be available for the beekeeper.

POPULATING THE HIVE

The simplest way of filling a hive with bees is to place the hive in position, complete with foundation comb, at a season

when swarms are numerous, that is to say, just before the rains break or as they are coming to an end, and to hope for the best. One's chances of success vary considerably with the locality, but may be increased somewhat by following the native method of attracting swarms to log hives by mixing a little bees-wax with live coals and holding the hive in the smoke till the odour is well absorbed.

A more satisfactory method is to place a number of wooden boxes, such as petrol cases, in which one or two holes have been bored with an augur, in trees in a number of localities. When a swarm has taken possession of one of these boxes, the holes are sealed with clay in the late evening and the box carried to the hive. Early the following morning, the roof and inner cover of the hive are removed to expose the frames in the brood chamber, and one or two frames are removed so that the spaces between the remainder can be increased. The box is opened and inverted over the brood chamber, a few sharp bangs with a stone on the bottom of the box dislodge the bees on to the frames, and the box is removed. The bees are gently swept from the top bars of the frames and the inner cover replaced, followed by the roof. As in all operations with bees, this must be carried out deliberately, and without abrupt movement. A native assistant who is used to handling bees, and who will not panic when they get angry, is of great help.

It is also possible to shake a swarm found clustering on a tree branch into a box, and so introduce it into a hive. The writer has not tried this method with the East African bee, and so hesitates to recommend it to any but those who are quite immune to stings.

A colony may be transferred from a hollow log or bark hive to a frame hive. First the native hive is opened and the bees driven to one end with smoke. A number of combs containing brood are cut out with a sharp knife, and fitted into empty frames, where they are held by means of supporting tapes, so that the bees will subsequently attach them to the frames in the correct position. In fitting these combs it is essential that they are kept the right way up, as the cells are not quite horizontal, but slope downwards to the inside. The frames are placed in the centre of the brood chamber and the roof replaced. The bees are brushed off the remaining combs on to a white sheet which is tied to the floor board of the new hive and spread out in front of the entrance. The success of this method depends on the queen being transferred undamaged, otherwise the colony will move off. If the queen can be spotted and carried undisturbed on a piece of comb into the new hive, all is well. Otherwise one must depend on her being among the crowd shaken on to the alighting board or its sheet extension and attracted into the hive. If the original hive was situated in the vicinity of the apiary, it should be brought in at night and placed on the stand later to be occupied by the frame hive. The bees are then given about a week to become used to their new surroundings before the transfer to the new hive is made. This is not an easy method, and only to be recommended in an area where bees are comparatively docile—if such are to be found in East Africa.

After a newly hived swarm or transferred colony has had five or six days in which to settle down, a brief inspection of the hive should be made to see that comb-building is proceeding satisfactorily, and if possible to make sure that the queen is present, either by actually seeing her or finding eggs in the combs. If all is well, leave the hive alone for a month or two before opening again.

(To be continued)

Labour and Land in Native Reserves

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Agricultural officers in East Africa, as in other similar territories, are faced with the task of creating a new rural system in replacement of one which has outlived its usefulness. The fact of the introduction of European control alone has rendered the indigenous systems obsolete, even apart from the desirability of raising the living standards of the people to a level more in conformity with Western ideas.

As the authorities found even in the totalitarian state of Russia, it is difficult enough to create a new rural economy by fiat. In a state in which democratic principles prevail it is an impossibility. Changes can be brought about only by gradual evolution. The African cannot be expected to see the drift of events in the economic sphere or on his own initiative to make the necessary adjustments; furthermore, he is subject to some degree of persuasion towards standards of satisfaction which have not arisen spontaneously in him; he does not always believe that his real satisfaction is bound up with what is, in our opinion, good for him.

Under the British system, any new development is foredoomed unless it is planned with due regard to the existing system of rural economy. It is therefore necessary first of all to study the system and then to discern how it can be adapted in the direction desired. In the following notes attention is confined to the Central and Nyanza Provinces, as the same treatment of the subject is not easy to apply to the problems of the Coast Province.

LABOUR

True economy in agricultural operations consists in making the greatest possible use of the most valuable factor of production. Of the three factors, land, labour and capital, labour is usually the most valuable in primitive communities. Land is abundant and has little value. It can be wasted with impunity, and we have the waste involved in shifting cultivation, in relatively permanent separation of cultivation and grazing land, numerous balks between small irregular cultivation patches, lack of swamp draining, etc. Capital is little required, and in any case it can be regarded as a derivative of labour, the stored product of labour retained to assist in future production. The fundamental element in the real cost of production is labour. This may sound paradoxical when applied to a population often looked upon as a source of labour for use outside the native reserve, but the fact remains that the real cost of labour to the native is measured by the dissatisfaction involved in carrying it out.

Hence, under primitive conditions, any new development must make a minimum demand for labour, in proportion to the satisfaction which will be derived from the product. Certain forms of development present no complications in this respect. The use of seed of improved strains, for instance, may increase the produce from a unit of area without any additional labour except the slight increase for gathering the heavier crops. Consideration of such general improvements would carry us beyond the scope of this article.

LABOUR SAVING ON "SHAMBAS"

An obvious means of facilitating further development is by the introduction of ploughs and other implements, which

make it possible to increase output without corresponding increase in the amount of human labour required. It is realized, of course, that this is attended with grave danger of soil erosion. The danger arises not so much from the use of animal draught implements as from their misuse, and it is considered that advantage can be taken of the economy offered without incurring the penalties of misuse. The feasibility of the use of ploughs depends upon the topography of the land, and in Kenya much of it, particularly in the Kiambu, Fort Hall and Nyeri Reserves, is too uneven to allow of their use. Elsewhere, as in the Nyanza Province and in Machakos, they have made much progress. Over 3,000 were sold in 1936 by Kisumu merchants alone.

There would seem to be a large field over much of Africa for devising and adapting small inexpensive implements suitable for ox-draught or donkey-draught. In this connexion a small Hindustani type of plough is of interest. It is very light, and can be drawn by two oxen or two good donkeys. Its cost is only Sh. 23. Adaptation of the labour-saving devices available to the market gardener in European countries, and co-operation between implement manufacturers and agricultural staffs at this end, might be well worth while.

In certain areas a limit of groundnut production per family is being reached because of the length of time taken in hand shelling. The introduction of a shelling machine would remove this limiting factor. It is possible that a similar consideration applies in the case of maize, owing to the fact that the hand shellers on the market are constructed with handles insufficiently strong to withstand the kind of treatment they receive from primitive workers.

Bird scaring sometimes occasions a considerable drain on the available labour time. In the Kikuyu Reserve in former years the work of guarding the millet crop extended over an extra month or so because the practice was to mix up millet from direct sowing with a transplanted portion. Efforts were made to wean them from this practice. Subsequently, awned bulrush millet has been introduced with the same object. Rice growers are being persuaded to co-operate with their neighbours in the matter of times of sowing and of transplanting, so that, besides facilitating the control of irrigation water, they can take turns in the work of irrigating and bird-scaring.

Increased production is often secured with a less than proportionate increase of labour by making fuller use of the first clearing and breaking. This is accomplished if the cultivation period is lengthened by the introduction of improved rotations, by the use of compost, and by the use of animals to provide manure. It is also secured by interplanting and catch cropping, whereby additional crops are secured from the same basic cultivation. The use of the bunch groundnut is being fostered in the Nyanza Province for interplanting with cotton. In the same Province the simsim crop forms a useful short-rains advance catch crop; fresh land is usually broken for it about July, the crop is harvested in November and December, and the land is already partly prepared for maize or wimbi (*Eleusine coracana*) to be planted in the new year. Where maize is grown in the cotton areas of North and Central Kavirondo it is now becoming more usual to cultivate between the crop of ripening maize and to plant cotton, which then grows under protection until the harvesting of the maize, on land the initial cultivation of which might be considered to have been already debited to the preceding economic crop.

The Agricultural Officer, Fort Hall, noted in 1936 that a native in the district

interplanted his cotton on a plot of 4½ acres with rose coco beans, the cotton being planted in rows three feet apart and one foot apart in the rows. The beans were harvested before the cotton had produced bolls; the crop amounted to 3.79 bags per acre, and realized a total of Sh. 129. The cotton produced a yield of 1,548 lb. first quality and 2,502 lb. second quality seed cotton, equivalent to 430 lb. per acre, and realized a total of Sh. 202/62. The gross return per acre was thus Sh. 78, of which the cotton accounted for Sh. 48 and the beans Sh. 30.

So much for economy in the total amount of labour involved in agricultural production. But labour cannot be considered as a homogenous commodity. In the first place there is man labour and woman and child labour. The use of animal-draught implements is of value, not only because it reduces the total amount of labour-hours required and lightens one of the heaviest tasks, but also because it induces a more even distribution of the labour between males and females—oxen being in the care of the male members of the family. Increased cotton production is possible partly because the small children can assist in the picking, and partly because the idea has been infused that new cash crops are a man's concern.

Seasonal Distribution of Labour

The most important factor, however, is the seasonal distribution of labour. Agricultural operations have to be carried out with reference to the relation between weather and crop, and peaks of labour requirements arise which set a limit to development. There is a conspicuous lack of quantitative information on seasonal labour requirements, but officers of experience can generally put their finger on the weak points in the system of any particular district.

The main peak of labour requirement, if we neglect the light labour of harvesting, is in the period of soil preparation near the onset of the rains. A distinction has to be made between one-season and two-season districts.

In one-season districts in the lower parts of Kavirondo the introduction of cotton has fitted in well with the seasonal distribution of labour. It is planted when the main food crops are already half way through their growing season, and is harvested some four months later than the food crops. Paddy rice produces two crops in the year, and the work falls at periods slightly different from the rush periods of the main food and rain-produced crops. Cassava is being introduced to reduce the height of the labour peak on food crops.

In other parts of Kavirondo there are two crop seasons—a long and a short one. In these areas the extension of cotton cultivation has fitted in with the seasonal distribution of work. Planting is done about June or July, when long-season maize and millets are ripening, and picking takes place from January to March. In some cases the cotton-planting season clashed with the wimbi harvest, and in order to overcome this difficulty a more early maturing variety of wimbi—"Bukura"—was evolved by selection. Incidentally, the selection proved a heavier yielder than the unselected indigenous varieties. It saved labour not only by avoiding a rush period by also by making it possible to take the crop on old land instead of breaking up fresh land for the purpose. Two new early sorghums have been developed by selection and trial, and are now in cultivation by natives.

Since much of the field work is done by women, economy in domestic tasks plays its part. Wattle cultivation and tree planting generally, besides bringing other advanges, reduces the time taken in searching for and bringing home firewood. In

the Nyanza Province small hand grinding mills have been introduced to replace the former laborious method of grinding with pestle and mortar or with a loose stone upon an exposed rock surface. In the Central Province considerable numbers of Indian-type water mills have been installed by natives. Much of the time of the women is taken up with the daily task of drawing water, often from some little distance, and in the Central Province the inhabitants are being encouraged to dig village wells of the bucket and windlass type.

Transport

Another avenue of economy in labour is the elimination of the head-load as a method of taking the produce to market. A disadvantage of motor transport, however, is that it is expensive and sometimes cuts off remote areas. This occurs when it becomes a habit and alternative means have been discarded. An instance could be cited from Kisii in South Kavirondo, where at one time maize was worth only Sh. 2/75 for export at Kendu, 30 miles away. Motor transport to Kendu cost Sh. 1/25 per bag, and hence, deducting the cost of the bag, little remained for the grower. The harvest consequently remained for weevils and rats to assist in its consumption. If the grower had been able to transport it by pack ox or donkey to Kendu he would at least have been able to earn the Sh. 1/25 per bag for transport and the community in general would have benefited to the extent of the export value. Low value crops in Meru are still, for the most part, inaccessible, with a haul of a hundred miles over a winding earth road intervening between the produce and outside markets. Nowadays, however, one may see groups of pack donkeys leisurely traversing the distance to Sagana, with a 60 lb. load on each side. The hundred-mile distance is very considerably shortened by the ridge tracks which cut off the hairpin bends of the graded motor roads. At least 4,000 donkeys are in use in Kiambu district; many are kept in Fort Hall and Embu, and their use is spreading to Nyeri. Numbers may be seen at some of the Kavirondo market centres. The possibilities of pack transport are impressed upon one by the example of the coffee estates in some parts of South America, where the coffee is brought down the mountain tracks for distances as great as 100 miles by trains of pack mules, each carrying a 132 lb. bag of coffee on each side.

The supply of donkeys in the agricultural districts of Kenya is inadequate. Considerable numbers exist in the pastoral areas of the Masai and Northern Frontier districts and Samburu. Mutual advantage would accrue from the exchange of agricultural produce from the agricultural areas for donkeys from pastoral areas. A further advantage would follow if donkeys were to come into use in part replacement of the goat as a wealth reserve.

The replacement of the head-load by animal transport is often assumed to be associated with the use of vehicles. Occasionally the use of donkeys as pack animals is deprecated on the ground that the animals would be grossly overloaded and generally ill-treated, but this is by no means always so, and in any case the practice should be preventable. With the use of carts there arises an unfortunate tendency for them to be owned exclusively by a class of native middleman who contributes little to the working of the economic system, but contrives to exact a wholly disproportionate reward at the expense of the grower. This development might be discouraged if carts were cheap enough for a large proportion of the actual cultivators to acquire. In certain very densely populated areas the cart has the advantage that a heavier load per animal

is possible and the need for grazing accordingly reduced.

While on this subject, mention may be made of the rapid ascendancy in these days of the pneumatic-tyred roller-bearing form. In England many of the old farm vehicles have been converted by fixing axles and wheels from broken-up motor cars. Under farm conditions, pneumatic tyres will last until the rubber perishes, and tyres discarded from motor-car use will serve for a long period on a farm cart.

The majority of native cultivators have a surplus of cattle, a proportion of which could be quite successfully used as pack animals if trained early. An attempt was made in the Nyanza Province to start such a movement, but for some reason the idea excited the risibility of the natives.

Land

Passing now to the subject of land, the problem of effective utilization becomes insistent only when a shortage appears. This stage has already been reached in several parts of Kenya. Shifting cultivation is accompanied by a shorter and shorter bush fallow as the proportion of cultivated land increases. A simple numerical example will show the importance of this factor. Suppose a family to have a holding of twelve acres, three of which are under cultivation at any time, remaining so for three years. Suppose further that the efforts of the Agricultural Department should result in an addition of a further three acres to the cultivated portion. The length of the bush fallow will thereby be reduced from nine years to three. The serious effect of increase of cultivation in densely populated areas needs no further emphasis. There are areas in the Colony where the proportion of fallow land is already so low that live stock husbandry has had to be restricted.

Most of the improvements in labour utilization which have been mentioned above economize also in the use of land. Improvement of crop yields, shortening of growing periods and introduction of catch crops and interplanted crops are cases in point. Other measures, such as terracing and composting, economize in land, but not necessarily in labour. In general, as the pressure on the land increases, more intensive cultivation must be resorted to; it becomes economic to shift the emphasis from labour to land. The operation of the law of diminishing returns to land is postponed for a little time by movement into sparsely populated areas, as can be seen, for instance, on the borders of the Masai country from Limuru to Ngong. Some alleviation is provided by swamp drainage, such as is being carried out in the Fort Hall and other districts; as also by the additions which are being made to some native reserves on the recommendation of the Carter Commission.

Efforts are being made to discover rotational systems which will admit of a lengthening of the cultivation period without any additional drain on the soil. This will tend to lengthen the recuperative bush fallow. The cultivation of wattle, whether the crop be regarded as part of the crop rotation or as analogous to the bush fallow, plays something of the part played by the introduction of clover in British agriculture. It is one way of obtaining revenue in a period otherwise merely recuperative. This is so, whether the revenue is considered as the cash received from the sale of bark and wood, or the various "consumption goods" which the tree affords directly. At the same time, the soil is held together and enriched with humus and nitrogenous residues.

It is not likely that crop husbandry alone will solve all rotational problems,

and at some stage the incorporation of animal husbandry in the system is necessary for further progress. Two courses are open. One is to call a halt to development on the arable land and endeavour to turn the live stock kept on the bush fallow to greater economic advantage. For this purpose, enclosure of grazing lands, better pasture management, and attention to meat and milk production will be necessary, for—

"More profit is quieter found (where pastures in several be)
Of one silly acre of ground, than champion maketh of three."[1]

In this direction we are brought up against an obstacle in the system of land tenure fundamentally the same as that which in European countries took upwards of four centuries to surmount—the transition from collective to individual control.

The other alternative is to allow encroachment on the bush fallow to take its course, and to concentrate upon providing a place for live stock on the arable holdings. This involves reliance on stall feeding with arable forage crops, rather than on natural pastures, though for some time to come pasture will play an important part. The effect of reduction of the proportion of land in grass and subsequent lengthening of the cultivation period must, however, be countered by using the live stock to provide manure. Deeply entrenched customary practices in regard to live stock retard progress in this direction. It is first of all necessary to devise successful systems of management and to demonstrate their success.

In the meantime, demonstration has taken the form of smallholdings based on a combination of grass and arable stock farming; in other words, on the assumption that the bush fallow will be enclosed and made subject to individual control.

Demonstration smallholdings are being carried on at a number of centres, including the Scott Laboratories, Bukura, Machakos, and a number of Local Native Council seed farms. Demonstration and education are yielding tangible results. In the Central Province there are now over 1,100 grazing paddocks; and over 750 Napier grass paddocks have been established during the last two years. The feasibility of the use of Napier grass, wattle, sisal, and other economic crops for the triple purpose of erosion control, fodder production and fencing is being examined.

[1] From Tusser's *Five Hundred Points of Good Husbandry*, written in the 16th century, when the enclosure of common grazings in manorial England was a live issue. The passage may be paraphrased thus: More profitable use can be made of one acre in individual occupation than of three acres of open common.

The Problem of Quality

[*Below we publish extracts from the "Report of the Commission of Enquiry on the Scientific Department, Indian Tea Association," Calcutta,* 1936, *pp.* 58-72. *Their direct appeal is to the tea planter; but it is primarily for their indirect appeal to the coffee planter that we reproduce them. No coffee planter can read far without perceiving that the problems of tea quality are his problems; nor fail to find most of the failings and difficulties of present systems of assessing quality in coffee stated here with challenging clearness. It may well be that this important report has lessons for the coffee industry no less than the tea industry.*]

In tea-tasting, quality is one of those undefined components, body, aroma, etc., being others, by which the market value of a tea is determined. But in tea-growing circles and for crop products at large, the word quality is used to include all the characteristics or components which govern market value. We have found it desirable in our discussions to use the word in this general sense and have so used it throughout this report.

The problems connected with quality have been the most difficult part of the scientific side of our work. They are, firstly, not at all easy to formulate, as every section of our witnesses has found. They constitute the greatest challenge which the tea industry can make to science. We believe that in the economic future of the industry they will have a leading and, it may well be, the chief place.

The Meaning of Quality

Quality, at the present time, can only be defined as a conception, more of art than of intellect, of which tea tasters are repository and by the aid of which teas are valued in commerce. How they apply this conception to a tea is well known. Their judgment is decisively expressed by a price and they explain it by reporting on certain components of quality, such as pungency, colour of the liquor, etc. In reporting on these components they make use of a great number of descriptive words and phrases. The list of components referred to is not necessarily the same in reports by the same taster on different teas or by different tasters on the same tea. Of the relative monetary importance of the individual components of quality nothing is said. This, indeed, for one and the same tea, may not be the same in the judgment of different tasters, who may have personal predilections arising from the particular market demands they may have in mind. The descriptive words and phrases used in connexion with the several components of quality exceed seventy in number. Some are synonyms, some are variably used by different tasters, and some are, at any rate outside tasting circles, obscure in meaning.

A Dangerous Situation

Discussions with all sections of the tea industry, in which we have been most cordially assisted by the tasters themselves, convince us that present methods of specifying tea quality are in some respects commercially undesirable, while for science they completely rule out constructive investigation. They create, therefore, a dangerous situation. It is our chief concern here to propose measures by which this obstacle to research can be removed, but we think it desirable to review first the commercial aspects of this question.

The brokers' report is passed on to the planter. If the price be unexpectedly low, he naturally wishes to find out the particular characteristics in which his tea was faulty. He would then, of course, connect the faults with the circumstances of the

leaf or the manufacturing, and take immediate steps to improve his quality. But in many such cases the report is obscure and, indeed, virtually meaningless, leaving the planter entirely without guidance. We think it of the greatest importance to the industry that the brokers' report should not be limited, as in effect and usefulness it sometimes is, to a cash valuation. He should give such information as to the faults and merits of the teas on the market ruling as to guide the planter in his policy. This he cannot do unless he speaks in terms as to which the planter has no doubt.

Terminological obscurity, amounting almost to mystery, in dealing with tea quality may come to have serious marketing implications, especially for the higher quality teas. Present-day consumers dislike buying mysteries, and in commodity markets generally there is a strong demand for declared and regularly maintained grades. Producers of apples, bacon, eggs, prunes and many other familiar commodities are making strong efforts to meet this demand. Now the subtleness of tea quality makes grading, of the kind easily developed with ordinary food products, unattainable with tea. We doubt, however, whether the tea industry can safely continue to do nothing to change the system by which quality is judged and specified. That almost all tea reaches the consumer as a blend does not, in our view, weaken the arguments here used. The desirability of change in commercial practice is not, however, our direct concern. We turn therefore to the scientific need for a new specification of quality, which is a matter of the first importance and of the greatest urgency.

Scientific Requirements

There are two reasons why present methods of specifying quality, when used in connexion with scientific investigation, are an insurmountable obstacle to progress. Only the taster can say what the quality of a tea is, for the tea trade will listen to no one else. Thus he becomes a key-member of the scientific staff in any experiment on quality, e.g. a study of the effect of different manurial treatments on quality. But taster A may differ from taster B; and actual test has sometimes given whimsical proof of this. Here is the first difficulty. Now different plots receiving the same manurial treatment in an experiment may, for instance, give very different yields because of soil variations. But these differences are in a form which science, by the principles of statistics, can safely and appropriately deal with. Differences in brokers' verdicts, however, in their present form, are a phenomenon with which science cannot deal. We have explained earlier how easy it may be to account for at any rate some of the differences between one broker and another. This explanation, of course, does nothing to remove the obstacle to scientific study.

The second reason why current ways of specifying quality impede investigation is even more serious than the first. It must always be an aim of science to connect cause and effect. Let us take, for illustration, an experiment on the effects of nitrogen, potash and phosphoric acid on quality. It will be necessary to apply varying doses of these three substances and various combinations, e.g. nitrogen only, nitrogen and potash together, and so on. The planter naturally wishes to know how each substance, in light or heavy amount, and how each combination of two or three of the substances at a time, affects the quality of the made tea. The scientist can arrange an experiment to produce teas from every one of these manurial treatments, arranging at the same time a most careful check on the "statistical reliability" of the results. The whole, elab-

orate experiment must now be consummated by the tasters' deciding on the quality of the tea from every plot. With present practice, the only information in a taster's report which has for all teas a constant purport is the price. But price does not meet scientific requirements. It is essential to know how each manurial treatment has affected each component of tea quality—briskness, the colour of the liquor, the body. Moreover, this information must be given under the same headings and in the same form for all teas from all experiments. What is required is summed up by saying that a uniform and analytical system for specification of quality must be evolved. The uselessness and even danger of a specification in which price is the only significant data is at once apparent. Two teas from an experiment may be worth the same price, one being outstanding in one characteristic and one in another. Price would thus not help in connecting individual causes with individual effects in the way which has been explained to be necessary.

We attach the greatest importance to the analytical specification of quality. Without it, proper scientific study will be impossible; for lack of it a very great proportion of past experiments on quality has, in our view, been made utterly worthless and a waste of time.

The Ultimate Scientific Specification of Quality

Quality, however wide its range and obscure its nature, must depend on the properties of certain chemical substances present in the tea. These, in turn, are derived from certain chemical substances in the green leaf as a result of chemical and physical changes during manufacture. If these substances could be identified, and if their effects on the palate could be fully worked out, it would be possible to make exact scientific definitions of all grades and aspects of quality. It must be the research workers' ultimate ideal to identify these substances and their properties. But there must be no misunderstanding about the parts science and tea-tasting are likely to play in buying and selling. If exact physical and chemical tests of quality can be devised, they will be of great value in research and so lead to increased control over manufacture. On the market, however, large numbers of samples have to be valued in a short time. Rapidity is therefore essential, and no chemical or physical test is likely to be of at all the same order of rapidity as tasting.

Proposals for Specifying Quality for Experimental Purposes

We should be concealing an aspect of much significance if we did not record that evidence given to us reveals a sharp difference of tasters' opinion between London and Calcutta upon certain questions connected with experimental teas. We have considered many reasons which help to account for this difference, but do not think it necessary to give them here. In our opinion, if the expert bodies in London and Calcutta both assist Tocklai in experiments on quality, difference of opinion between them will be by degrees removed, and, indeed, unless fundamental differences can be removed, the tea industry of North-East India will have to admit the unsatisfactoriness of a situation of which the crippling of scientific work will not be the only bad feature.

We propose the following arrangements for judging and specifying the quality of experimental teas:—

(*a*) That a limited number, preferably not more than six, components or characteristics of quality, be always reported on. These should be the characteristics which best combine commercial importance and suitability for experimental purposes.

(*b*) That in reporting on each characteristic, one and the same system be used for indicating level of excellence. Several systems are possible. For instance, the taster using his general experience might award marks for each characteristic out of a total of 10. One objection to this would be the inevitable tendency of some readers of reports to look on the total marks of any tea, for the selected characteristics, as indicating its all-round merit and relative market value. The system we favour is a comparative-value one. In any experiment, one tea, usually that from the control plots, should be taken as the standard of quality. Then for each characteristic in turn every other tea should be reported as equal to, better than, or worse than, the control. There might be three, four, or even five degrees above and below equality with the standard, each denoted by a single suitable phrase, e.g. better (or worse), much better, and very much better than standard.

(*c*) That personal bias and the specific requirements of particular markets be prevented from affecting reports by arranging for a panel of three or four brokers to make a single, joint report. Each broker would prepare his own report, and the panel would then assemble and make the joint report. There should be one such panel in London and one in Calcutta and each should send its reports to Tocklai and to the other panel. The samples from an experiment should be sent to the tasters under serial numbers or other suitable marks, the identity of the standard being disclosed. The key to the serial numbers should be given to the tasters immediately after their report is completed, to enable them to know the value of the experiment before their recollection of the exact characteristics of the teas has ceased to be fresh. Our evidence encourages us to believe that brokers will be prepared to play their part in such a system, and will, moreover, take a keen interest in the results of the experiments. We have carefully considered the alternative to joint report by a panel of brokers, i.e. individual reports. It has the advantage of securing repetition of result and so permitting of statistical analysis of brokers' opinions. While we adhere to our preference for a panel, we point out that no amount of reasoning can decide between the two systems. Trial alone will show which is the better for scientific purposes.

(*d*) Careful preparation, involving many preliminary experiments and the closest collaboration between the brokers and the Scientific Department, will be needed to launch this system. One important point to decide will be the number of samples and the size of each to be sent to the brokers from each "treatment" in any experiment. The question of water for tasting will also arise. In commerce it is always insisted that most careful allowance be made for local water peculiarities in blending. Whether corresponding allowance is made in tasting straight teas in, it may be, London, Melbourne and Calcutta, seems uncertain. One body of witnesses explained that the water supply in one well-known place, interested in tea, varied with the seasons of the year. For experimental purposes, careful provision for tasting water must be made. Possibly a plan worth considering for uniformity in experiments would be that adopted by one large commercial house, which uses distilled water.

(*e*) One of the most difficult matters to settle is the number of different teas, from any one experiment, which tasters can be expected to judge with certainty. The research worker might well desire to have in, let us say, a manurial experiment, eight treatments and a control (i.e. no manure). This would give nine lots of tea. We learn that it is difficult for the taster to discrim-

inate the differences among six different teas, at most, when these are as close in quality as they have usually been in past manurial and other experiments. It must be remembered also that plot experiments are "replicated", e.g. several plots are laid down for each of the treatments. The fact gives rise to yet further questions which will have to be dealt with in the preliminary investigations.

Some General Aspects of Research on Quality

Our discussions have convinced us that in some sections of the industry the magnitude and difficult nature of a proper study of tea quality are imperfectly realized. Partly for this reason, but also as part of our own consideration of the quality problem, we therefore briefly discuss here two general aspects of research on quality. One is the problem of sampling, the other the range of possible experiments.

The "problem of sampling" runs all through every kind of research in which material and procedure are not perfectly constant. Suppose, for example, the effects of the various stages of manufacture on quality are to be studied. To give as much constancy as possible, let it be assumed that the green leaf can be obtained from the following closely specified conditions: a block of one acre of land; the bushes on it all to be of exactly the same jat and of the same age; cultivation, manuring, plucking, and pruning to be the same all over the block. Now the soil will certainly not be uniform over any acre, and thus the green leaf from different bushes cannot be entirely uniform. The whole bulk of material from this acre could be manufactured, but a chemist could not analyse it all. He would have to draw small samples from it for analysis. His results would differ from sample to sample. By analysing a great number of samples from the bulk he could find out the "range of variation" within the bulk, and by familiar statistical methods he could decide how many samples and the size of sample it would be necessary to use to get an average figure properly representative of the whole bulk and to a stated degree of accuracy. It is essential thus to study the "sampling error" at every stage. This study makes it possible to test the "reliability of result". Without ascertaining this reliability, the greatest perfection in the actual procedure of weighing, analysis, etc., is of no avail, and dangerous false inferences may be drawn. An essential principle for calculating reliability of result is repetition of observations, e.g. several sub-samples from the bulk in the case under discussion. It is this principle which necessitates having several plots for each different kind of manure in a trial of the effects of different manures on yield. Correspondingly, when the effects on quality of the various stages of manufacture have to be studied, the chemist will have to draw several samples of the material after withering, after rolling, etc. Moreover, any one stage, e.g. firing, cannot be carried out in precisely the same way on different days. How much the day-to-day variations may affect the made tea can only be found out by repeating the firing (or other process) a number of times. Thus the sampling problem must be a subject of special study at every stage as a preliminary to systematic investigation of the effects of that stage on quality. These considerations show that every plan of investigation implies, in practice, a series of "repetitions" by which the investigation is greatly enlarged beyond the skeleton form of the proposals written out for it. Research workers have to deal with the problem of sampling in every experiment. The layman must understand its general nature and the principles by which it is dealt with if he is to appreciate the requirements of accurate experimentation.

The Vast Field of Research on Quality

The magnitude of the field of research opened up by questions relating to quality in tea is impressive to the point of dismay. It is obviously essential for the research worker to examine the scope of possible inquiry with care. We think it highly desirable also that those who pay for or are otherwise interested in tea research should give careful thought to this matter. It is for them we contribute the outline considerations which now follow.

To understand the quality problem from the point of view of the investigator it is necessary to make a complete theoretical analysis of the factors governing quality. These constitute two groups, associated respectively with the raw material (green leaf) and with the stages of manufacture, and may be thus set out (with sufficient completeness to illustrate the principles involved):—

Green Leaf

1. Jat.
2. Inherent physiological condition of bush.
3. Age of bush.
4. State as affected by spacing, pruning.
5. Nature of plucking.
6. Locality (altitude, etc.).
7. Soil.
8. Cultivation.
9. Disease.
10. Time of year.

Manufacture

1. Withering.
2. Rolling.
3. Fermenting.
4. Firing.
5. Storage and transport in India.
   Sea transport.
   Warehousing.

The finally made tea is influenced by each one of these factors, and the effect of any one factor is partly controlled by the effects of the other factors preceding it in action. Thus the influence of firing depends upon, among other things, the effect tnat manuring has had on the leaf, while this in turn is influenced by the jat of the tea concerned. For every factor in the list above a considerable range of variation is possible. Many different jats could be tried; at least six different kinds of manuring could be described as of practical interest; any one of the factors (i.e. stages) in manufacture could be tried in several different forms or degrees, e.g., for firing, two different temperatures and two different time exposures. Thus for a theoretically full study of quality, suitable variations or degrees of every factor should be tried in combination with those of every other, each set of combinations producing a different "experimental tea". There are 15 factors mentioned in the list above. If only two variations of each were possible, the total number of combinations of factors, i.e. the total number of separate tea-makings, would be $2 \times 2 \times 2$—15 times = 32,768. With an average of three variations for each factor the number of tea-makings would be 14,348,907. To bring the possibilities back to manageable numbers, let it be assumed that 5 factors can be selected from the 15 as being the only ones likely to matter much—a big assumption. Then taking the number of variations of each factor as 2, the number of necessary tea-makings will be 32; for three variations per factor the number will be 243. These reduced though still big numbers do not, however, disclose the magnitude of the experimental work involved. Any one tea-making (i.e. combination of factors) would have to be subject to repetition to ensure reliability of results. At least four repetitions, multiplying correspondingly the above numbers of experimental tea-makings, might well be required. If chemical

analyses of raw material were made at the beginning and end of each stage of manufacture, the number of samples to be analysed would be several times multiplied again. This would bring numbers once more to levels of impracticability. It will be realized that this account does no more than mention the experiments which might conceivably and not unreasonably be undertaken if resources allowed. The carrying out of some stages, especially for instance the chemical analysis of the leaf and the products derived from it, would in practice be very lengthy and intricate. The conclusion we wish to make clear is that great care must be shown in deciding what experiments to make on quality; that only a few can be carried on at one time; and that, for these, ample resources and a considerable span of time are necessary.

Notes on the Susceptibility of Indigenous Trees to *Armillaria*

By G. B. WALLACE, *B.Sc., Ph.D., Plant Pathologist, Department of Agriculture, Tanganyika Territory.*

In an editorial note in the last number of the Journal a summary was given of recent researches by the Department of Agriculture, Nyasaland, upon the important root diseases of tea caused by *Armillaria* sp. These researches suggested that loss might be avoided if, in an area of forest selected for later planting with tea, all indigenous trees whose roots are susceptible to this fungus were ringbarked and allowed to die before felling. The following notes are based mainly upon my studies of this disease in the Usambara Mountains of Tanganyika.

The susceptibility of indigenous trees in a living condition appears to be small. The roots of dead trees, on the other hand, are very much more susceptible, and it is probable that dead roots of the majority of both rain forest and savanna species can be infected.

Armillaria has been found as a parasite (i.e. on *living* plants) in very few indigenous species. Of forest trees in Tanganyika, only the comparatively small but common tree, *Trema guineensis,* has been found infected in a living condition. Of trees growing at lower elevations or in savanna the following have been recorded as living hosts of the parasite: in Tanganyika Mvule (*Chlorophora excelsa*) and an *Acacia* sp., and in Uganda *Bauhinia* sp., *Erythrina* sp., and *Ficus* sp.

To say that a species is resistant is more difficult, and the only case fairly substantiated is that of Camphor (*Ocotea usambarensis*), of which many stumps up to twenty years old have been examined and found free from *Armillaria.*

As regards dead roots, the host range is wide, but not yet well defined. On one large Usambara plantation the majority of the species of standing trees were identified; also the susceptible species of dead stumps, where recognizable, were listed. This list appears below with botanical names supplied by Mr. P. J. Greenway, Botanist to the East African Agricultural Research Station, Amani.

I am glad to be able to state that through the generosity of Mr. C. Gee, of Ambangulu Estate, an area of forest will be made available for investigations to be based on the findings of Leach, and to corroborate field experiments now under way in Nyasaland. The Usambara studies will be commenced on my return from leave at the end of this year.

SPECIES OF FOREST TREES WHOSE DEAD ROOTS, AFTER FELLING, HAVE BEEN FOUND INFECTED WITH *Armillaria* SP.

Kishambala.	*Botanical Name and Notes.*
Mnyasa	*Piptadenia Buchanani* Baker (Mimosaceae): Locally common through East Africa on mountains and as a riparian tree.
Msambu	*Allanblackia Stuhlmannii* Engl. (Guttiferae): In Tanganyika only in the Usambaras, Ngurus and Uluguru Mountains.
Mshai	*Albizzia maranguensis* Taub. (Mimosaceae): Kilimanjaro, Pares, W. Usambaras, and Nyasaland, but its distribution is probably wider. There are about thirty-eight species of Albizzia in tropical Africa, and *A. gummifera* (Gmel.) C. A. Sm., with which it might be confused when in leaf, is very widespread in Africa.
Mbarika	Most probably *Berlinia Scheffleri* Harms, but also applied to species of *Cynometra* (Caesalpiniaceae). The Berlinia is known as the Shoe Tree. Both are endemic to the east and the eastern side of the W. Usambaras.
Mura, Mula	*Parinarium Holstii* Engl. (Rosaceae): Locally widespread in Tanganyika and Nyasaland.
Mnyohoyo, Muyohyo ..	*Sersilisia usambarensis* Engl. (Sapotaceae): Endemic to the E. and the eastern side of the W. Usambaras.
Msangana	*Strombosia grandifolia* Hook. f. (Olacaceae): A West African species appearing on Mts. Kenya and Meru, E. and the eastern side of the W. Usambaras, and as far south as Nyasaland, where it is recorded as *S. Scheffleri* Engl.
Mfunda	*Cynometra* sp. ? (Caesalpiniaceae).
Mwuhande, Muhande	*Schefflerodendron usambarensis* Harms. (Papilionaceae): Endemic to the E. and the eastern side of the W. Usambaras.
Mshinga, Msinga	*Trema guineensis* Ficalho (Ulmaceae): A tree usually appearing as a pioneer species in secondary forest, but found in abandoned native cultivations at sea-level to 6,000 feet altitude; widespread through tropical Africa, also in Arabia, Natal and Madagascar.
Mkonde	*Myrianthus arboreus* P. Beauv. (Moraceae): A tree widespread through tropical Africa, from Sierra Leone to Nyasaland.
Mkuyu	Applied to several species of Fig, but believed to be *Ficus capensis* Thunb. (Moraceae), which is widespread through tropical Africa and to S. Africa and the Cape Verde Islands.

Kishambala.	*Botanical Name and Notes.*
Mbanghu, Bankhu	*Odyendea Zimmermannii* Engl. (Simarubaceae): Endemic to the E. and the eastern side of the W. Usambaras.
Mnukhuntu, Mnkhuntu ..	*Harungana madagascariensis* (Choisy) Lam. (Hypericaceae): Widespread through tropical Africa, usually as a pioneer in secondary forest from sea-level to about 6,000 feet alt.
Mlungu	*Cola usambarensis* Engl. (Sterculiaceae): Endemic to the E. and the eastern side of the W. Usambaras, but the genus is rich in species through tropical Africa.
Mkungwina	*Sorindeia obtusifoliolata* Engl. (Anacardiaceae): Common through E. Africa, especially on the coast. Also applied to *Trichilia emetica* Vahl (Meliaceae), which is widespread in Africa, also Arabia.
Muhkwe, Mukwe	*Chrysophyllum Zimmermannii* Engl. (Sapotaceae): Endemic to the E. and the eastern side of the W. Usambaras, but the genus has many species which are found through Africa.
Msala	*Anisophyllea obtusifolia* Engl. & v. Brehm. (Rhizophoraceae): Endemic to the E. and the eastern side of the W. Usambaras.
Muhka	Probably *Microglossa densiflora* Hook. f. (Compositae): A Cameroon Mtn. shrub, found also in E. Africa.
Mgugfa	*Piper umbellatum* L. (Piperaceae): Tropics.
Mkokoko	

Fundamentals of Grazing Management

[*The following paragraphs are reproduced from Bull. No.* 168 *of the Department of Agriculture and Forestry, Union of South Africa.*]

The Plant

The plant in the form of a seed starts life small in size, and closely attached to a relatively large store of plant food which is needed for a short period after germination. The first function of a germinating seed is to produce a root and leaves. The root absorbs moisture and mineral salts, and the leaf absorbs carbon dioxide from the air and energy from the light rays, from which, together with the water and mineral salts, it elaborates plant tissues. The leaf is the factory where the sun's energy is made available for the plant's use. Initially, sugars and starches are elaborated in the leaf, and these foodstuffs enable the root to grow bigger. At maturity, flowering and fruiting take place, after which the plant either dies or stores reserve foods in root, stem or leaf, so that the plant can survive through the long winter and can shoot out again with the return of spring.

Considering the life of perennial grasses, growth is of two kinds—

(1) Critical, or transfer growth.
(2) Active growth.

Critical growth is that growth which takes place in early spring, beginning when the plant is completely dry above the ground, and only storage organs at ground level and in the root retain life. The first leaves sent up are elaborated out of the storage supply from the previous season; that is, during critical growth, the shoot grows out at the expense of the root. As the leaf increases in size and becomes green, it starts elaborating plant food for itself, and later elaborates plant food not only for itself but for replenishing the storage materials in the root. At this stage, active growth is said to take place; that is, both shoot and root grow simultaneously. Later in the season, the green leaves of the grass grow much less rapidly, but they remain green and living for a month or more in late summer. At this stage the leaves elaborate foodstuffs for storage in the root, to ensure survival throughout the oncoming winter. This is another phase of transfer growth. The process takes place in every plant whenever conditions allow of it. The grazing of a plant by live stock has a disturbing effect on life processes. During early spring, for instance, heavy grazing of young shoots, which have been produced largely from the stored-up food in the root, before they have had a chance to replenish the root system, exerts a seriously damaging effect on the root. The more often the grass is grazed in spring, the weaker the root system must become, and this affects the growth of the plant throughout the ensuing summer.

Grazing during midsummer, when active growth is taking place, has less effect upon the plant, unless severe overgrazing is practised. A fair proportion of the green parts remain after grazing, and active growth can continue simultaneously. Heavy grazing in autumn tends to curtail the amount of storage of reserve foodstuffs needed for survival during the dry winter months, and for re-growth in the following spring. During the winter it is likely that grazing has little effect upon the stored reserves in the plant, and mainly converts the dry plant-remains into dung. The duty performed by the dry plant in acting as a blanket during extremely cold winters is in all probability significant.

Apart from these general considerations grasses vary greatly in their capacity to withstand grazing at different seasons. Matting and other low-growing types of grass, such as the Woolly Finger (*Digitaria Pentzii*), Kikuyu (*Pennisetum clandestinum*), and Kweek (*Cynodon* sp., including "Bermuda Grass"), produce an abundance of leaves and runners, intertwined and protecting one another. It is very difficult for the grazing animal to remove all the green leaf from any individual plant of this type during periods of growth. This low-growing type of grass is definitely suited to grazing, and, indeed, in many cases, if left ungrazed, may be crowded out by more rankly growing tufted kinds of grass which can intercept light with their leaves and water with their roots.

There is another type of grass, generally considered as a hay type, which tends to grow rapidly upwards, with the formation of long stalks with leaves all the way up. It seems likely that little reserve food is stored in the root until aerial development is well-nigh complete and the plant has set seed. As examples of this type may be quoted many of the tufted sweet-veld grasses in the more arid regions, which suffer severely if grazed before they approach maturity.

In many velds there is a mixture of these two types of grass. The question of whether one or other is dominant in a particular area is influenced from year to year by the incidence of rainfall and also to an overwhelming degree by the grazing to which the veld is subjected. Close grazing obviously tends to remove the tufted types, and the low-growing types take possession. At this stage the greatest care is needed to maintain these grasses through wet and dry years, so that they may not be over-grazed during drought. If the shorter types are over-grazed and killed out, what will take their place? Weeds, pioneers and unedible plants; alternatively, erosion. It is probable that in such a mixture, especially in arid regions, the presence of a safe balance of tufted and low-growing grass should be maintained, and that the rapid disappearance of tufted types should be used as an indication that the farm is in danger of being over-grazed.

The Animal

An adequate supply of food is required uniformly throughout the animal's life. Under correct extensive-farming conditions, the veld is lightly stocked, is grazed to its capacity in severe droughts, and at all other times is only very lightly grazed. Under such treatment, the veld remains in full vigour, and in the arid parts of the country the large quantities of dried grass in winter supply the requirements of the grazing animals. As stated earlier in this article, times have changed. Over large areas such light stocking is no longer possible, and the veld, instead of being grazed short only in periods of exceptional drought, has come to be stocked as nearly as possible to capacity every year. Systematic seasonal veld resting, or other means of maintaining veld vigour, though absolutely necessary under these conditions, does not receive sufficient consideration. The result is that the animals suffer periodically during their lifetime from starvation. The wide variation in veld production from season to season and from year to year, coupled with the fact that the veld is stocked as nearly as possible to capacity, inevitably results in periods when the supply of feed from the veld runs short. This state of affairs renders provision for these periods, by supplementary feeding from hay or arable land produce, a necessity. The effects are seen in all directions. A starving animal on an over-grazed or even vigorous veld is an exceedingly destructive agent. Concomitant with the damage to the veld—

which becomes apparent in ensuing years —is the damage to the productive capacity of the animal. Certain types of grazing animal grow fast in periods of plenty, and cease to grow when the food supply is decreased below a certain limit. When an adequate food supply is again available with the return of rain, the animal starts to grow once more. Of such a type are Afrikaner cattle. With many exotic breeds, however, of so-called "improved" stock, the animals have been bred as efficient machines of production which require a high nutritional level sustained throughout their lifetime. In general, "improved" stock lack the power to withstand reduced rations, and fail accordingly to recuperate with the return of good times.

It is thus necessary for each farmer to decide what course pays best on his particular farm. Whether to keep comparatively slow growing, hardy stock, capable of withstanding periods of food shortage, or to keep rapidly maturing "improved" stock, is a question on which there is a great diversity of opinion. The increased cost of production due to supplementary feeding is to some extent off-set by the improvement in the animal, which can be of a better type. The opinion is held by many, however, that this is not worth while, and that a type of animal is needed which can stand periods of extreme shortage. Certainly such a type of animal needs less spent upon it in the form of fencing and ploughing for supplementary feed, but it takes longer to mature. To a large extent the economy depends on the cost of grazing. Is the cost of the extra period of grazing less or greater than that of the supplementary feed necessary to shorten the period before maturity?

Of late years, another far more important factor has played its part. The periods of shortage of veld, if supplementary feeding is not practised, are periods of intense over-grazing of the veld. Even if there is an animal which produces satisfactorily in spite of periods of starvation once or twice or more times in its life, the question arises as to whether there is a veld which will stand up to the intense over-grazing which coincides with the periods of shortage. Certainly, in large areas of semi-arid country of the Union, the changes in veld consisting of wholesale destruction of plants and erosion which have followed this system of farming, show most definitely that the veld cannot stand up to such a system.

Development and Organization of the Bwamba Robusta Coffee Industry

By W. J. MILL IRVING, *B.Sc., A.I.C.T.A., Agricultural Officer, Department of Agriculture, Uganda Protectorate.*

INTRODUCTION

Bwamba is the most westerly county of the Toro district of Uganda. It is situated between the northern portion of the Ruwenzori Mountains and the international boundary rivers of Semliki and Lamia, beyond which lie the rain forests of the Belgian Congo. Its climate and ecology are in marked contrast to other parts of the district, for it is a land of steamy heat, luxuriant vegetation, and tall forest, intersected by numerous streams flowing fast and clear in deeply cut ravines. The forest-clad foothills and snowcapped peaks of Ruwenzori tower above its boundary on the Toro side, their imposing height accentuated by the low altitude from which they are viewed, a great part of the country being little higher than the 2,028 ft. level of Lake Albert. There is much dense forest, terminated to the north by the Lake Albert flats, a rolling plain of grass and scrub which reverts to semi-swamp conditions during the rains.

Access to the country is difficult, and the main trade route, if such it may be called, is an arduous track crossing a mountain saddle at a height of approximately 8,500 feet. All goods entering or leaving the country must be head-portered across the mountain, and there is no doubt that this primitive means of communication has done much to retard the development of the country.

Cultivation is most dense in a forest-free strip along the base of the hills. In other parts forest clearings, sometimes of considerable extent, are frequent, and on these virgin forest soils all crops exhibit rapid growth and return large yields.

The Baamba, the principal tribe inhabiting the country, are a primitive race, considered by authoritative opinion to be of pygmy origin. They are squat in stature, often light in colour, low browed and broad faced. Both sexes exhibit marked steatopyga, and usually wear no clothes with the exception of a loin-cloth. They have a cheerful disposition and mentally are fairly alert.

Amongst these polygamous people, the labour equivalent of individual families is high, and their potential agricultural production considerable. Until recently their wants have been few and simple. Surplus cash earnings have been spent mainly on the purchase of salt, meat and fish, but with a growing desire for other goods, such as cloth, blankets and utensils, they are bestirring themselves to greater effort to buy such things. This tendency has contributed, and is still contributing, to the development of economic crops in Bwamba, and is largely responsible for the satisfactory progress made in the cultivation of Robusta coffee, the staple economic crop of the country.

DEVELOPMENT

The inception of Robusta coffee cultivation on an organized scale in Bwamba is of comparatively recent origin, and dates from 1926. Prior to that date the crop was grown by a few natives who had obtained their plants while working on native *shambas* in Buganda and elsewhere.

In 1926, however, coffee plants were distributed to a large number of natives from central beds laid down in the pre-

vious year for that purpose. Subsequently, additional beds were established at other places as required, and a steady supply of plants issued twice a year to all would-be growers.

During the period 1927 to 1930 additional incentive to cultivation was given through the establishment of five plantations by the Native Administration under the ægis of the Agricultural Department. These plantations totalled 86 acres in extent, and were intended to serve an educational as well as a profit-making purpose.

During the first five years of development, private native planting progressed slowly but satisfactorily at the rate of approximately 35 acres per year, but the Native Administration demonstration *shambas* were the backbone of the scheme, being largely responsible for interest in the crop being maintained. From 1933 onwards, despite or possibly because of falling prices, larger acreages have been planted, and the average annual planting has risen to approximately 200 acres and the total area under cultivation to 1,200 acres. Approximately 80 per cent of the poll-tax paying population are now coffee-growers, and it is anticipated that future development will consist mainly of extensions to existing *shambas*.

It is considered that the industry is now sufficiently well established in the country to enable the demonstration *shambas* to be dispensed with, and these will probably be broken up and sold to local natives in the near future.

Cultivation

In the early days of development close planting was advocated for both private and Administration coffee plots. The spacing decided upon was 7½ ft. x 7½ ft. square planting, and it was intended that all plots so planted should be thinned out to a diagonal spacing of 12 ft. after the first crop had been picked. Shade of banana or *Ficus* sp. was employed on many *shambas* and in the early stages a purely natural growth of the tree, with the minimum of pruning, was encouraged. It was an interesting experiment, but under the forcing conditions of the Bwamba climate the trees rapidly became a mass of sappy suckers, producing little crop and providing ideal conditions for the breeding and spread of diseases and pests. In 1932-33, therefore, the cultural policy was revised, spacing was increased to 12 ft. x 12 ft., shade was abandoned, and a modified multiple-stem system of pruning was introduced. This system of pruning has proved very satisfactory. In the field the conversion is made very simply, merely by desuckering the trees to three main stems and stumping, while in the nursery beds all seedlings are topped prior to issue to the growers.

Mulching with elephant grass, with which Bwamba is plentifully supplied, has been encouraged since the inception of the industry. It is now generally appreciated as a necessary concomitant of coffee growing, not only as a method of improving growth and cropping, but also for its effect in reducing the labour expended on cultivation. Complete mulching is usually carried out. Strip mulching is not popular because frequent cultivation of the bare land between the strips is found to be necessary. As a result, root pruning and root exposure are apt to be severe, with a consequent tendency to dieback.

Newly planted and young coffee which has not yet reached the cropping stage is invariably planted with leguminous crops such as beans and groundnuts, primarily with the object of keeping the land covered and secondly to ensure that the plot receives adequate weeding.

Owing to the necessity for reducing maintenance costs, mulching has been discontinued on the Native Administration *shambas* since 1932, and instead they have been cover-cropped with *Centrosema pubescens*. This has given a very effective cover, and cultivation has been reduced to an occasional slashing, forking to remove grass, and the periodic clearing of a small area around each tree to prevent the *Centrosema* from climbing. Labour charges for weeding have fallen from 76.3 to 42.3 man-days per acre per year since this cover was established.

Cover-cropping with *Centrosema* has not yet been extended to private plots, but the possibility of allowing a few of the larger cultivators to use it is being considered. It is becoming more difficult for the owners of large *shambas* to find enough labour for adequate maintenance, and there is little doubt that a satisfactory cover crop would help to solve their problem.

The experience gained in the cover-cropping of the demonstration *shambas* with *Centrosema* makes one regard it favourably as a substitute for mulching under Bwamba conditions. For example, the largest of these *shambas* has improved in general condition and yield until at the end of the past season the satisfactory return of 16.08 cwt. of hulled coffee per acre was obtained. Experiments are being conducted to test this matter further and in more detail.

Organization

The five Native Administration plantations are run by a staff of headmen and storekeepers under the direction, in all cultural matters, of the Agricultural Officer of the district. The present annual wage bill under this head is equivalent to only Sh. 30 per acre. On a crop basis these charges amount to only Sh. 2/16 per cwt., or approximately 20 per cent of the total value of the crop at current yields and prices.

For handling the crop each *shamba* has a pulper provided with an ample supply of water, and a hulling machine for hulling either parchment or dry cherry. All coffee is pulped if possible, but at the height of the picking season, when the pulpers are unable to cope with the daily pickings, it is often necessary to sun-dry much of the cherry.

Each *shamba* is provided with locally made reed drying trays, augmented by a few wire trays. The stores are of mud and wattle and thatched, and again reeds are employed for the erection of the necessary interior storage bins. The equipment, therefore, is of the simplest description, and after the initial outlay on pulping and hulling machines the *shambas* have been almost self-supporting.

As regards private native coffee, the bulk of the crop is made into dried cherry and hulled by pounding in a mortar. Consequently much of the coffee offered for sale contains a high proportion of crushed and broken beans. Hulling facilities are available for private growers at all the Administration *shambas* on payment of a nominal fee, but a comparatively small proportion of the growers take advantage of them. This service is being brought into closer contact with growers by erecting small hulling stations at suitable centres in the county, and it is anticipated that the quality of the coffee offered for sale will improve as a result.

The organization for the supply of coffee plants to the growers requires little comment. A nursery is maintained at each Demonstration *shamba* from which plants are issued as required to neighbouring cultivators. A distribution is made twice a year, and each would-be recipient is required to produce a certificate from his

Miruka chief or agricultural instructor that his plot has been properly holed and prepared before he can obtain plants. Seed for these nurseries is obtained at present from selected trees on the demonstration *shambas,* preference being given to 'Nganda types, but seed plots have been laid down for future supplies.

The supervision of cultivation on private plots is in the hands of a small staff of native agricultural instructors. They are under the charge of the overseer referred to above, who supervises their work and directs it as required. One of the more important functions of these instructors is to see that pruning and de-suckering are carried out adequately, an aspect of private cultivation which requires constant attention under Bwamba conditions.

Marketing

Prior to 1934 there was little organization of marketing. The crop of the Administration *shambas* was disposed of by local contract, while private growers sold their coffee either in Bwamba or Toro, accepting almost any price which was offered by the Indian merchants.

Difficulty of access to the country was largely responsible for this delay in providing suitable marketing arrangements, all coffee having to be head-portered across the mountain to Toro. It was early realized, however, that the future development of the industry depended largely upon the provision of a more economic form of transport. There are many obstacles to road making, but in 1935 work started on a road connecting Toro with Bwamba, which should be completed in 1937.

Marketing has been improved by applying the Native Produce Marketing Ordinance to Bwamba, and inviting tenders for the purchase of the crop under licence. In June, 1934, one licence was issued under the usual regulations, the licensee undertaking to purchase all good coffee offered for sale at a price 5 cents below that of the Kampala price of hulled coffee. The Kampala market price for Robusta is obtained weekly, and the price in Bwamba adjusted accordingly.

On the whole, this system of marketing is working satisfactorily, and although it is unfortunate that prices have fallen so rapidly since its inception, it now has the confidence of the majority of growers and their chiefs. Adequate supervision of sales is possible, and there is no doubt that the 5 cents allowance for handling, transport and profit enables the growers to obtain a very fair price for their coffee.

Yields

Yields on the Administration *shambas* have been recorded since their inception, and show steady progress. The yields per acre taken over all *shambas* have risen from a maiden crop of 5.3 cwt. of hulled coffee per acre to 12.8 cwt. per acre. In 1936 one of these *shambas* cropped at the very satisfactory rate of 16.08 cwt. per acre without showing signs of undue strain. Accurate figures of yields on private plots are not available, but it is considered that when adequate care and attention to cultivation is given, similar yields are obtained. The combined crop of Administration and private *shambas* for the 1935-36 season amounted to 3,282 cwt., approximately double that of the previous season.

Insect Pests

The most important pest is the coffee berry borer, *Stephanoderes hampei.* This pest has been the subject of an interesting and successful experiment in biological control which is briefly described below. Damage from berry borer was first noticed in Bwamba in 1929-30, and by 1932 the infestation was extremely heavy. In that

year the Government Entomologist visited Bwamba and came to the conclusion that the rapid spread of the pest was due largely to the absence of its natural parasites. Contributory causes were close planting and inadequate pruning, as already described which, by providing an unduly shady habitat, tended to prevent the parasite establishing itself. By a change in the system of pruning and by thinning out to give a wider spacing, these predisposing factors to the spread of the pest were largely removed; and subsequently *Prorops nasuta,* a hymenopterous parasite, was introduced which rapidly took control of the situation. By 1934 a very marked improvement was noticeable, and by June, 1936, the pest was to be found in large numbers only in a few isolated places and usually on plots on which pruning and thinning had been neglected.

At the height of the infestation the loss of crop due to this pest was estimated at 50 per cent, and the whole future of the industry was seriously threatened. The position still requires careful watching, and from time to time the necessary steps are taken to ensure that the parasite continues its profitable activity.

Other pests have not given much trouble and their incidence has been mainly localized. Aphids, scales and capsids are found most commonly, and, of the latter, a Tingid bug has been noticed in association with severe *Hemileia* disease.

Only one severe outbreak of root aphid has occurred, in which about 75 per cent of the trees were attacked and destroyed. In general, where plots are maintained in a healthily growing condition by attention to mulching and pruning, little trouble has been experienced from either pests or diseases.

Conclusion

The future prospects for the industry are promising. Planting continues to be progressive, indicating that the Baamba are satisfied with the crop and the profits to be made from it, although in this connexion it is perhaps fortunate that the general increase in cropping capacity of the trees has compensated them for the recent fall in prices.

The industry has attracted the attention of other tribes, and a number of Batoro, Baganda, Swahili, and Nubians have settled in the country and cultivate fairly large *shambas.* At the present time it is estimated that 25 per cent of the total acreage is cultivated by these settlers, whose *shambas* average 1.4 acres in size per head.

There is little danger, however, of the Baamba being swamped by an influx of foreign settlers. Existing settlers are already beginning to find some difficulty in obtaining porter labour for their *shambas,* and it is probable that the extent of future settlement from outside will be limited by this natural economic factor.

Control of Primary Production: a Review

By V. LIVERSAGE, *B.Sc. (Lond.), M.S. (Wis.), N.D.A., Agricultural Economist, Department of Agriculture, Kenya Colony.*

During the last decade or so we have seen the inception of a considerable number of group organizations of primary producers designed to secure a greater measure of control over the marketing of their products. " Here is no mere extension, or quickening of previous development . . . here is something so fundamental and so novel as genuinely to merit the adjective 'revolutionary' and so vigorous in its growth as to command our utmost attention." Control schemes of regional, national and international scope have been set up, some of them directly supported by Government. East Africa has not been backward in the movement. The best known are, of course, those of international scope, and as agriculturists we are particularly interested in those relating to tea, coffee, sugar, rubber, wheat, and cotton.

In the sense understood here, control means something more positive than that typical of the agricultural co-operatives. In these latter the chief emphasis is on voluntary organization of the producing and marketing mechanism—bulking of small lots, grading, elimination of wastes, etc. In the newer control schemes the emphasis has been on control of price, and the terms "restriction schemes" and "valorization schemes" are used interchangeably.

An interesting and instructive account of some of these schemes is given in *Markets and Men,* by J. W. F. Rowe. The book is based on a series of wireless talks by the author, and follows publication of a series of monographs by the same author, published by the London and Cambridge Economic Service.

The origin and growth of control schemes is traced, and it is shown that, contrary to a common impression, they are not particularly a feature of the recent depression. That for rubber dates back to 1922, that for sugar to 1926, while coffee was almost continuously controlled from 1917. Before 1929 there had been experiments in artificial control on a sufficiently large scale to affect world prices in wheat, sugar, coffee and rubber, while schemes were being generally discussed in connexion with cotton. It might be added that before the turn of the century attempts had been made in the United States of America, the results of which foreshadowed in some respects the experience of fifty years later.

The growth of monopolistic control in secondary industries before the war probably pointed the way for primary producers, whilst the war provided the occasion for drastic forms of economic intervention. Certain of the subsequent control schemes grew directly out of wartime measures, and the fashion was thus set. Whereas the monopolies in secondary industry had been set up without Government aid, and even in the face of official disapproval, in primary production Government aid was often solicited and generally given. The point is stressed that the need for restriction schemes seemed not to diminish but to grow with the increasing world prosperity of the period 1926-29. "The producers of many foodstuffs and raw materials were experiencing such difficulties, as the result of excessive supplies and falling prices, that they were induced to experiment with artificial control schemes as a means of lessening the existing strain." "In almost all cases it will

be seen that fundamental difficulties arose from the existence of a total productive capacity so much in excess of what was required to meet the demand that the price could not be even mildly profitable to a substantial proportion of that capacity." It is suggested that this was largely due to rapid advances in the technique of production, as exemplified by the invention of the combine harvester for wheat. The fall in prices in 1929-30 caused the virtual breakdown of most of the control schemes for the time being, but with the shrinkage in demand the problem of surplus producing capacity became more than ever insistent. Hence "old schemes were revived, revised and extended, and new schemes were set on foot".

The record to date of the chief control schemes is not an imposing one. Certain causes of failure occur with distressing frequency. Perhaps the chief of these is the persistent failure to discern potential sources of fresh competition, and to allow for the fact that in a given state of the world an increase in the profitability of an industry relative to other industries will inevitably bring about a movement of labour and capital towards it. The Brazil valorization scheme stimulated competition from the "mild" countries. The Stevenson rubber scheme resulted in a large increase of exports from countries outside the scheme, chiefly the Dutch East Indies, and in the use of reclaimed rubber. The United States of America cotton control is stimulating increases in several countries, notably Brazil. If the price is too high production will be unduly stimulated within the restriction area itself, as has happened in the Brazil coffee industry. Where important advances are being made in productive technique, a price which will maintain obsolete capacity above the profit line will provide an incentive to increased production on the part of modernized units. This was the case with wheat after the introduction of the combine harvester, and also with the Cuban sugar industry, where modern mills set up with American capital existed side by side with out-of-date small-scale units. The reaction of consumers was not sufficiently regarded; consumption was reduced, and huge stocks piled up. Finally, the dangers arising from Government action were not foreseen, and there were instances like the events following the Chadbourne Sugar Scheme, where in a short space of time India passed from a large exporting country to a state of self-sufficiency; or the action of the wheat importing countries in stimulating their domestic production under tariffs sometimes higher than 100 per cent *ad valorem*. In the majority of cases it seems rather as if a multiplicity of small maladjustments, which would have existed under conditions of *laisser faire*, but which might not have worked in the same direction and hence might have cancelled each other to some extent, had been exchanged for a single large maladjustment, the force of which had been concentrated in one direction. In many industries high cost producers have been able to maintain their position at the expense of low cost producers, owing to their entrenched position, "with the result that the low cost producers have borne the full brunt of the decreased demand. Consequently, the extent of the adjustments which are now required if the world's economic system is to give maximum production at minimum cost, or even to work in any reasonable and commensense way, is greater than ever."

Summarizing the effects of restriction as they have worked out to date in the schemes examined, the author concludes that, (*a*) restriction is unsound as a means of meeting a permanent decline in demand, and is more than likely to intensify the difficulty of the inevitable readjust-

ment; (*b*) it is sound as a means of meeting a temporary decline in demand, but only if technical improvements have not rendered any substantial proportion of the productive capacity obsolete; (*c*) it is unsound as a remedy for troubles arising from excess productive capacity.

Applying these conclusions to the control schemes which have been introduced since 1929, the disturbing observation is made that nearly all these apply to industries which were already suffering from over-production before 1929, and, therefore, fall under (*c*). On the other hand, most of the primary industries which might legitimately have established restriction schemes, since their troubles were solely due to the world trade depression, have not done so. Perhaps this is due to the drawbacks of a restriction scheme: "it always involves a great deal of complicated administrative machinery; it often involves the dislocation of speculative markets and the antagonism of merchant-speculators and middlemen generally, whose services are most valuable in normal times; it demands faith in the integrity of those controlling the scheme as well as in their ability; and unless the scheme covers every producer it will greatly benefit the outsiders temporarily, and even perhaps permanently." The restriction schemes which have been established have been, however, less in the nature of forward economic planning than attempts to retreat in reasonable order from a position which has become untenable.

The control schemes so far in operation have been directed mainly or entirely by producing interests. They have been dominated by cost-of-production theories which have been long discarded by economists. Herein perhaps lies one of their chief weaknesses: an attempt to control prices without a thorough scientific knowledge of how price-making forces work. The matter has received examination by the recent Milk Reorganization Commission, so far as it concerns the marketing of milk in Great Britain. In this scheme, producers were given power to form a compulsory pool and to fix the price of all milk sold, for whatever purpose. A Milk Marketing Board, the members of which were elected by producers, was set up to give effect to this provision. The general effect of the Board's decision has been to maintain or even increase the price of milk sold for liquid consumption, during a period when prices and incomes in general have been falling. The result is seen in an index number for milk standing at 171 (in November, 1936), as compared with 129 for agricultural commodities in general. So far this is satisfactory from the milk producer's point of view. But it has naturally had the effect of inducing a considerable increase in the supply of liquid milk. Even before the scheme came into operation the supply of milk was considerably in excess of the requirements of the liquid milk market. The surplus had to be sold for manufacturing purposes, where it came into competition with imported supplies and had to be sold at a much lower price. As the surplus increased, the average pool price was necessarily reduced. The Board thus found itself in a dilemma. Either it must reduce the retail price of liquid milk and attempt to increase consumption, or it must reduce the pool price to farmers and stem the flood of increasing supplies, or it must bring in some form of production control which would be likely to be extremely unpopular with producers. Actually, it has found it impossible to take a bold decision in any of these directions, but has been able to sell the surplus at better prices with the progress of world recovery.

The Commission examined the work of the Board and concluded that "they are

no different from what might be expected from any body of business men engaged in selling a commodity and naturally intent upon obtaining for that commodity the best possible price . . . they must be tempted to strive after immediate benefits without regard to the ultimate consequences." "As a matter of long-term policy, it is in our view impossible satisfactorily to build up a producer's price from average or modal costs and estimates of reasonable profits. The ultimate test must be whether or not, over the long period, the price offers sufficient inducement to producers as a whole to produce the quantity of milk required." The appointment of a permanent independent Commission is therefore proposed, "composed of persons of exceptional talent and experience . . . those who show conspicuous ability in finance, industry, commerce or administration in the widest sense would furnish the type required."

Perhaps we must wait for history to show whether such an independent body will make a better job than producers themselves. The more flagrant weaknesses may be avoided, but it remains to be seen whether effective planning in one industry is possible without parallel planning in other industries and co-ordination by a central planning authority. Some may doubt whether, even in a completely planned economy, the knowledge, wisdom and freedom from sectional partisanship will be forthcoming to produce a real improvement upon what might be called a policed *laisser-faire* system.

A Rational Formula for Pruning Multiple Stem Coffee*

By W. F. DELAP.

FOREWORD

Mr. Delap's article entitled "A Rational Formula for Pruning Multiple Stem Coffee" gives sound advice on general pruning, namely systematic "cutting up" of all primaries which have borne within a few inches of the tip—this usually coincides with two years' cropping—and "handling" out excessive secondary growth.

In regard to establishing a new cycle of suckers, Mr. Delap advocates stumping the best head at a height of 1 ft. 6 in. above ground level; this, in my opinion, will cause undue loss of crop, and I am not convinced of the necessity of establishing subsequent suckers only on the best or strongest vertical. It is my experience that strong healthy suckers are produced from any original healthy verticals.

Referring to the formula, it is of interest to note that I recently visited Mr. Delap's coffee plantation and was impressed with the pruning he had carried out. I formed the opinion that the pruning carried out on the formula as described in his article arrived more or less at the same result as that advocated by the Department of Agriculture.

ARTHUR TRENCH,
Late Senior Coffee Officer.

DEFINITIONS

Definitions of terms used in multiple stem pruning:—

"Distance from ground": The distance from the ground to the point where the lowest primary branch grows from any of the multiple stems at any particular date.

"Cut-up space": The space between the highest and lowest height of the bottom primary at the beginning and end of a cycle. At the beginning of the cycle, the lowest height of the lowest primary which will prevent the possibility of ant "contacts" with the primary tip is about 1 ft. 2 in. At the end of a cycle the height from the ground of the lowest primary is about 5 ft. 2 in. These figures are intended as a standard only.

"Cycle": The period of growth from the removal of a head (to cause sucker propagation) until one of these suckers is itself removed to begin another cycle.

"Cycle start": The date when a head is removed to begin the growth of new heads for a new cycle.

"Clearance interval": The clear space kept between the top of a new head and the bottom primary of the old head to allow sun and air to penetrate to the new heads.

"Suckers": Unwanted heads above the required number, or those growing outside the "head renewal region," or those growing in a restricted position.

"Head renewal region": The space on the multiple heads, near the ground, whence it is desirable that new heads should start for a new cycle.

"Knob": The old inch or two of a multiple stem between the point at which a head has been removed and the point at which a new head, or the highest situated of the new heads on that stem, grows.

"Best head": The head which is removed to begin sucker propagation.

The Senior Coffee Officer has been kind enough to write a foreword to this article which deals with certain variations in

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methods now widely adopted largely as the result of experiments and propaganda by his Department. As Mr. Trench writes, so is it also my experience that strong, healthy suckers are produced from any original healthy vertical, but I believe in the desirability of obtaining the establishment of subsequent suckers on the "original best head" when possible.

It is not unusual in Donyo Sabuk district to meet planters from other districts on a "busman's holiday". More often than not, they study with interest the variations in the methods adopted for the cultivation of multiple stem coffee, in a district where there are a number of notably successful examples of this system.

There is a widespread conception of "multiple" as a particularly simple pruning system, but this is only partly true; the system adopted on these plantations has evolved from the cultivation of "multiple" during the last nine years. Although methods of coffee cultivation constantly undergo change and improvement natural to a very complex industry, this rational formula has now been adopted for several years, and has several notable advantages. These may be summed up, some as being inherent in the multiple system as a whole, others as what is claimed as a rationalized system.

The Usual System

There are examples of "multiple" in most coffee districts. The following is a rough summary of the methods generally adopted, and of the advantages gained when they are successfully practised.

The plants are "capped" shortly after planting, or they are bent over to force out "suckers" (Agobiada system). If "capping" is adopted, they are again "capped" to produce further heads up to three or four in number. The trees then grow in height, and after the first and subsequent crops they are progressively "cut up"; by this being understood the complete removal of all lateral primary branches which have borne to within a few inches of the tip. After a varying number of years, according to the growth and cropping of the trees, all primaries will have been removed up to shoulder height (about 5 ft.), by which time the stems, when bearing a crop, will lean out sideways, causing the "trees" to throw new "heads". These heads are "allowed to come" when it is obvious that the original heads can bear only about one more satisfactory crop owing to their height and "lean out". General opinion varies considerably as to the amount of cutting back of "whippy" primaries and handling out of excessive secondaries which should be combined with the above practice. Some plantations do no "handling" and "cutting back"—others do.

Very "Bold" Coffee

The method in general use of changing to a new "cycle" is that of "letting suckers come". This means that when individual "trees" are well "cut up" the more vigorous and well placed "suckers", up to three or four in number, are allowed to remain while the others are removed. When trees refuse to produce new suckers on this system, as happens in a considerable proportion of cases, they are lightly ringbarked, which usually has the desired effect of forcing out suckers in a healthy tree. The advantages of these methods of multiple stem pruning are well known. Outstanding is the fact that coffee is largely borne on new primary wood, that the new heads bear exceptionally bold coffee, and that the pruning required is quickly and simply done. Some difficulty is frequently experienced, however, in getting new heads to start, and after the initial cycles each tree will be at a different stage of growth in the cycle, due to the slowness of some trees

to produce suckers, and pruners have to treat each tree on its individual merits; the plantation will thus have a ragged appearance, a fact which not infrequently causes visitors to compare "multiple" plantations adversely with "single". It is not possible to give pruners any measure by which to "cut up".

The "Change Over"

By the formula systems, the "cycle" itself and the pruning operations during any "cycle" all operate from the "cycle start". A date is selected when it is decided to begin a new cycle on coffee already on the multiple system; or single system trees are stumped or changed over to multiple by ringbarking. It is a matter of great importance to put forward or to defer the date of a new "cycle start" according to the crop position on the *shamba* it is decided to change over. It is most desirable to change over to a new cycle at a time when (*a*) a crop has been picked off the trees and when the trees have recovered from any disease or dieback resulting from the crop. Again, the "cycle start" must not be delayed: (*b*) until the trees are about to flower and set another crop. This is not merely in order to avoid loss of crop by "head removal"; it is to ensure, in the first case, (*a*) that the trees are in good heart and the sap flowing, and that the new heads will be strong and grow quickly; also that (*b*) the crop will not begin to "tell" on the trees when the new heads are small and not well established. This latter is most important, as the coincidence of a heavy crop and very young heads will cause the latter to be stunted for some time. If, however, the new heads have already been well established they will, during a heavy crop period, be of great help to the trees by providing plenty of leafage coincident with the ripening of the crop.

When it is seen that a time has arrived which fulfils these requirements, a few picked pruners are sent through that *shamba,* and they remove the "best head" of each tree with a saw at a height of 1 ft. 6 in. above the ground level. They work in pairs; one man carries a measuring stick 1 ft. 6 in. long, with which he measures the point at which the head is to be cut off; he also carries a pruning saw with which he proceeds to cut off the head which the other man holds until it is sawn through, when he carries it to the nearest road where the heads are stacked until carted away.

To Simplify Banding

The best head of each tree is always that which is selected for removal; it is selected for its larger girth and more upright position. The size of the best head is the most important factor, but if there are two or more heads of equal girth, then the most upright is selected. The reason for selecting the "best head" for cutting is that it is desired that all three, or four, new heads should come from this one original best head. This is in order to simplify subsequent mealy-bug banding operations by having only one stem to band, since if all the new heads spring from the original best head the others can be removed entirely, and banding can be carried out on this stem alone. A further reason for the removal of the best head is that it is the most likely to produce vigorous suckers for head selection for the next cycle.

The month and year of the removal of the best head is always noted in the pruning book, and is the "date of cycle start" for that *shamba.*

An argument brought against the head removal method of cycle start is that it causes loss of crop. This will be seen not to be a serious consideration. If the cycle adopted by a plantation manager is that

of four years (which is quick), and if the plantation is one of 200 acres composed of four separate plantings or *shambas* of 50 acres each, then one *shamba* will be due to begin a fresh "cycle start" each year. Further, if the average number of heads on each tree is only three, then the loss of crop only affects one-third of 50 acres, or an equivalent of 16.33 acres, each year. This is more than compensated for, against the "letting heads come" method, by the ease and certainty with which the new heads are obtained.

Following the "cycle start" or "best head removal" there is a pause of a few months, during which large numbers of suckers are thrown out by the trees as the result of the interruption to the sap caused by the head removal. The suckers will then be some 8 in. long, and ready for head selection.

Head Selection

A small number of picked pruners should again go through the *shamba* with knives or secateurs, and select five heads on each tree. The heads selected must fulfil certain requirements: they must spring from the tree in the "head selection area"; that is, a space some 10 to 18 in. from the ground—the lower limit being that below which mealy-bug bands are liable to become easily inoperative by reason of earth contacts, etc. They must, if possible, all come from the stem of the original "best head". If there are not sufficient suckers on the stem of the original best head, then they must be also chosen from the stems of the other heads. They must, if possible, come from different sides of the "head selection region" of the best head. No head must be selected from a position where it is liable to become constricted by the adjacent heads as it develops. Freak or double heads must be discarded. Five heads are selected to allow of one loss through pickers, buck, boys digging, or other causes. This extra head is removed later if not required, to replace a damaged one. All vigorous trees will be found to throw enough suckers for head selection after the best head removal; it is the duty of the "head selection squad" to ringbark any that do not. No rigid rule is laid down for the head selectors; any number of heads from two to five will do. But five are nearly always obtainable; any tree with only one is ringbarked.

The new heads are by now well established, and a few months after the head selection has been completed they will not be adversely affected if the remainder of the tree bears a heavy crop. As far as the heads are concerned, the only need is for a watch to be kept that a space of one foot is free between the top of the highest of the new heads and the lowest branch of the primaries of the old heads, in order to allow space for sun and air to prevent the new heads from becoming too whippy.

The new heads and the old will flower and crop together one season, and after cropping, the old heads will be sawn off. While the old heads are bearing their last crop, the planter must not delay cutting off the lower primaries to allow space for the new heads.

The Old Heads Cut Off

The loss of crop is small, and the important consideration is for the new heads to be allowed space to grow.

This stage sees the new heads established by themselves. It is necessary to remove the knobs left on the original best head with a narrow saw also to paint all saw cuts with Stockholm tar, to prevent wood rot and allow the bark to grow over the scars. The saw cuts are pared with a sharp knife to leave a smooth surface.

Subsequent to the removal of the old heads, the new heads will require pruning, and then begin to bear a second heavy

crop. This brings up the important question of multiple stem pruning, apart from the operations necessary for successive "cycle starts" described above.

An Important Question

There is a wide conception of multiple stem that no "secondary" pruning is necessary, that pruning is merely "cutting up," that is, cutting off all primaries which have borne to within a few inches of the tip. This is clearly unpractical, since it is not at all uncommon for a young coffee tree or young "new head" to flower and set crop on every primary from top to bottom, and such a pruning method would reduce the subsequent bearing surface of the tree to nil! On most multiple plantations there is now done a considerable amount of cutting back to a vigorous secondary and "handling out" of excessive secondary growth. The trees bear largely on secondary growth towards the lower part of the heads at all stages of the cycle. The amount of pruning of this sort necessary is dependent on the length of the cycle adopted, and on the amount of leaf disease and dieback. A shorter cycle of four years will necessarily mean a rapid rate of "cutting up" and, in this case, many primaries will be removed, having borne only once, before they have had time to produce secondary growth. A slow "cycle" will entail the removal of a smaller number of primaries each year and the remainder will make secondary growth which will need regulation.

The Ideal Cycle

The best system aims at a cycle which is short enough to prevent the stems becoming stiff, and short enough to ensure sufficient "cutting up" to allow of most of the crop being borne on primary wood. Coffee will be borne on secondary and tertiary wood only on the lower primaries at all stages of the cycle. The cycle should not be so fast that the heads are too whippy and that the "cycle start" recurs too often. The actual period to strike a happy medium will vary according to the climate and rate of growth between three and six years. An important consideration when pruning trees which are about to produce a heavy crop is the proportion of growth which will *not* flower when the main flowering occurs. Pruners working on such trees should cut back thin, whippy primaries to a vigorous secondary, and a number of the smallest secondaries which will not bear when the main flowering occurs should be left deliberately, in order that the "make up" of the tree, when cropping heavily, shall include sufficient non-bearing surface for leafage.

A Formula to Check Cutting

When a planter has decided the desirable term for each cycle, it is a simple process to determine the height to which each tree should be "cut up" above ground level at any particular date. This is found by a formula:—

Distance above ground in inches equals the number of years from "cycle start" multiplied by x plus 14; x is found by dividing the "cut up" space by the number of years of the cycle. The "cut up" space is 5 ft. 2 in. (height from ground level of the lowest primary at the end of the cycle), less 1 ft. 2 in. (height of lowest primary from "new head" coming from the "head selection area").

Take a four-year cycle for example. To find the correct height from ground level at the third year from cycle start:

First find what x is—x is 62 in. (5 ft. 2 in.) less 14 in., i.e. $62 - 14 \div 4 = 12$.

x is always 48 divided by the number of cycle years.

Therefore the distance from ground at the third year from cycle start is:

$3 \times 12 + 14$ in. $= 50$ in., or 4 ft. 2 in.

A Reliable Standard

The planter can, using this method, give his pruners a stick 4 ft. 2 in. long, by which they can measure the distance to "cut up". It will be found that the distance reckoned by the formula will approximate very closely with what appears the correct distance to "cut up" when judged solely by the eye. It gives a reliable standard, and should be reckoned first and the result compared with what "looks right". Trees which differ from the rest, owing to having been planted as "blanks" or "misses" in a different season, can be brought into line with the rest gradually, by hurrying or slowing their rate of "cut up".

This combination of "cycle start" by head removal and the even rate of "cut up" given by working on the formula give the *shambas* a regularity and simplify pruning, since the pruners can measure the amount to cut up with a stick. It can be arranged gradually that there is never more than one *shamba* at the "change over" period at a time.

The amount of "cut up" on the remaining heads after the "cycle start" (best head removal) is not reckoned for, since it is only required to "cut up" these heads further, to leave the requisite space between the tops of new heads and the lowest primaries of the old heads until these are removed altogether.

Some Hints on Lining up Tractors and Ploughs for Maximum Efficiency and Minimum Draught

The farmer will naturally be interested in any information which will reduce the heavy cost of renewals on tractors and agricultural implements generally. With this end in view it is proposed to give here a few suggestions.

In designing an implement, the manufacturer must have constantly before him (*a*) the class of work the machine will be called on to perform, and (*b*) the stresses and strains which will be put on the various parts of the implement. The correct size, shape and strength of each component must receive his careful consideration. The question of size and strength will be readily understood by all, but sometimes the reason for a certain shape is not generally appreciated.

Take the beam of a breast or mouldboard plough: usually this will not be made from square section steel; it will present a narrow front and wide depth from front to rear, or it may be made from "H" section steel. With the plough in operation, the narrow portion will lead, and as all the strain will be from front to rear, the extra depth of metal gives strength which could only otherwise be got by using a heavier and costlier type of beam.

The importance of having the plough correctly lined up with the tractor is readily apparent, and all ploughs are provided with both lateral and vertical methods of adjustment. The lateral adjustment makes it possible for the plough to sit squarely to the job, with a line of draught in correct relation to the soil resistance.

In a multiple breast plough the line of draught starts from a point several inches above the bottom edge of the landslide—depending on depth of ploughing—and centrally, measured from left to right and back to front of the plough bottoms. This is a good adjustment to start from; it is then a very simple matter to make final adjustments if necessary.

The line of draught should be a straight line from the tractor drawbar through the hake to the point near the landslide mentioned above.

Another important point not generally known about breast ploughs is that they are designed to give both a bottom and a side suction to keep the plough steady in the ground. A straightedge placed against the concave bottom edge and concave side of the landslide and share will indicate this. The absence of this suction will prove that this landslide is worn (this should be put right by dropping the back end of the heel piece), or that the share is worn and needs replacing. An incorrect line of draught would neutralize the intended effect of the double suction.

Disc ploughs are more popular in Kenya, and a word in regard to this type would not be amiss. A correct line of draught with disc ploughs is probably more important than with breast ploughs. In the disc plough there is little to counteract the side thrust of the soil against the discs except the drawbar itself. As most disc ploughs in Kenya throw the soil to the right, the correct line of draught passes through the hake at a point somewhere between the central line mentioned in connexion with the breast plough and the extreme right-hand side of the hake. If the line of draught is too far to the left, there will be a definite tendency for the plough to throw out to land. When correctly set, the beam or beams should lie parallel with the ground, and in the case

of the disc plough the two furrow wheels should run well down in the furrow, and parallel with the line of travel. The flange on the wheel will occupy the lowest point of the furrow and the rest of the wheel will hug the furrow wall.

Incorrect settings will add as much as 25 per cent or more to the power required to pull the plough.

In both the disc and breast ploughs, provision is made for vertical adjustment. To illustrate the necessity for this, if the adjustment is set too low in relation to the tractor drawbar, the tendency would be for the front discs to plough a shallow furrow and the rear discs to plough more deeply. Not only would this setting give a bad ploughing job, but because the rear discs were going deeper than the front, the side thrust on these rear discs would send the plough to land.

So far, it has been shown that incorrect alignment and adjustment of the plough gives a bad ploughing job.

It has been seen that in the design and manufacture of ploughs, added strength has been given to parts such as beams on the assumption that the correct line of draught will be used. If there is a tendency for the implement to kick out in the rear or generally run crabwise, due to incorrect alignment, the side strain, vibration, etc., are greatly in excess of what the plough was made to stand. The results are heavy renewals bills, heavy labour charges, loss of time and much bad temper.

Another point of interest—generally known, but not always observed—is that *both* tractor tracks should always run on unploughed land and not in the furrow. The reason for this, and many other points, will be obvious after a little thought on the subject.

The writer's observations are based principally on caterpillar tractors and English implements, but will be found applicable in the main with tractors and implements of other makes.

In conclusion, it seems obvious that the owner or manager, either from the point of view of renewal costs or unnecessary work, should spend a little time periodically in checking up the draught, and thus prolong the life of both tractors and implements. Set your implements correctly and the results will be better, quicker, cheaper.

R. M. T.

Researches on Agave Fibres

Readers of the paper under the above title by F. J. Nutman, in the last number of the Journal, may have been puzzled by the text at the bottom of p. 476 (left-hand column) and Figs. 1, 2, 3 and 4 accompanying and illustrating it. The four *Agave* species were listed in the text in descending order of strength, *A. cantala* being the strongest. Owing to a misunderstanding, the four figures, which were drawn by the author on a uniform scale, were enlarged variously for reproduction. As they appear on p. 477 the magnifications are as follows:—

Agave cantala	480 diameters
Agave amaniensis	350 diameters
Agave sisalana	260 diameters
Agave fourcroydes	240 diameters

Thus, by comparison with the others, *A. cantala* appears quite erroneously as having a bigger cross-section, and moreover the greater fineness of *A. amaniensis* compared with *A. sisalana* and *A. fourcroydes* is quite masked. In fact, and as drawn by the author, these last two fibres have cross-sections about twice as large in area as that of *A. cantala*, and about one-and-a-half times as large as that of *A. amaniensis*.

Breaking in Young Oxen to the Yoke*

By J. B. WEST, *Dromoland, P/B Lonely Mine.*

There is no doubt that many farmers and transport riders would like to know of an easy and humane method of breaking in young oxen to the yoke. This operation is generally left to the native driver, and most farmers are unaware of the excessive cruelty these natives cause while doing so.

The method I am about to explain is very simple to make, and the two oxen, without any supervision, train themselves.

First procure two lengths of 2 in. or 2½ in. piping, 5 ft. 6 in. in length, and drill holes at the distances marked on

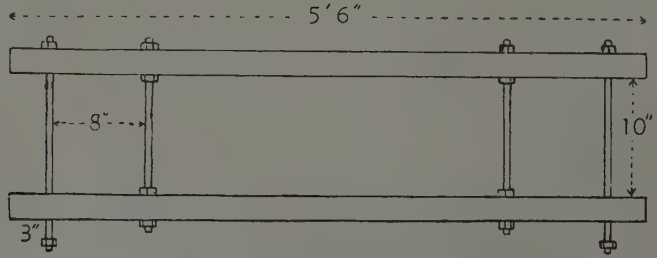

diagram to take ¾ in. or ⅞ in. round iron for making the bolts. The two centre bolts are a fixture, and must have about 4 in. of thread cut at each end to go right through the piping, and nuts screwed tight in order to obtain a rigid double yoke.

The idea of the double yoke is that the oxen cannot get themselves loose while attached to them.

The two outside bolts are simply dropped right through the two yokes when placed on the oxen.

When the outside bolts, which should be about 3 in. longer than the centre bolts, are in position, a loosely fitting nut can be screwed on by hand to prevent them from jumping out when the oxen are lying down.

After putting on the double yoke, do not take it off. Let the oxen graze with it on, and also leave it on when kraaling the oxen at night. You will notice that it is not cumbersome to them.

In about a week's time the oxen will have become so used to carrying the yoke that no difficulty will be experienced when placing them in the span with the older trek oxen, preferably in the centre of the span.

The diagram will explain the measurements suitable for oxen of two to three years old.

My reason for suggesting piping instead of round poles is that it is light and practically indestructible and will last for years.

These yokes can also be used for haulage by passing the chain or trek tow between the two yokes, but with heavy loads the 2 in. piping is liable to bend, so I do not recommend them for trek purposes, but only for breaking in young oxen.

* Reprinted from the *Rhodesia Agricultural Journal*, March, 1937.

Report on a Small Experimental Shipment of Fat Lambs to London

By R. DAUBNEY, *M.Sc., M.R.C.V.S., and* G. M. EAMES, *Dip. Agric. (Wye),*
Department of Veterinary Science and Animal Industry, Kenya Colony.

The view that a greater measure of diversification could with advantage be introduced into farming practice in Kenya is one which has been steadily gaining adherents during recent years. Mixed farming offers greater financial security whenever a sharp decline in the value of any of the basic agricultural products is liable to occur, and robs such losses of their crippling effect. Moreover, the introduction of stock to arable farms, which up to date have been operated on the one-crop system, cannot long be delayed if the fertility of the soil is to be saved. Hardly any small flocks of sheep are employed on mixed farms in Kenya, and the Report of the Meat and Live Stock Committee draws attention to this unusual state of affairs in para. 11, page 6:—

"The Committee observes that up to the present little or no use has been made of small flocks of sheep in mixed-farming operations. Here also the reason is to be found in the incapacity of the local market to absorb even the present production of fat wethers from the woolled flocks, which naturally discourages any effort on the part of farmers to breed mutton sheep or lambs."

It is suggested that for the mixed farmer in the more fertile areas the most profitable method of running a small flock of sheep is to keep them for fat-lamb production. Draft Merino or Romney Marsh ewes are available in considerable numbers from the large flocks, and for the farmer who wishes to embark on the new venture with as small an outlay as possible these draft or culled ewes under a suitable cross will provide lambs fit for freezing and an annual wool-clip of a certain value. The more prosperous farmer will naturally attempt to buy selected ewes with better wool, and if he is able to operate on a large scale he may even elect to keep a pure grade Merino or Romney Marsh flock himself in order to maintain his lamb-breeding flock of ewes at a high standard for wool and constitution. But in general it is to the prospective owner of a small flock of a few hundred ewes that fat-lamb raising will make its greatest appeal.

The objects of the present small experiment were—

(*a*) to ascertain whether under good mixed farming conditions aged Merino grade ewes could rear a fat lamb to the standard required by the overseas market;

(*b*) to obtain expert advice as to whether the conformation of first cross Merino-Southdown lambs is of the type acceptable on Smithfield Market, or whether for this purpose it would be necessary to breed lambs from cross-bred ewes; and

(*c*) to discover whether such lambs could be brought to marketable condition without any heavy expenditure on supplementary foodstuffs.

The Southdown ram used in the experiment was a good flock ram costing 11 guineas in England; the ewes were aged Merinos kindly given by several of the leading Merino flockowners. Only a small number of lambs (20) was available, the reason being that a ram lamb was sent from England by mistake instead of the shearling ram that was ordered, and after

his first twenty services he became temporarily sterile. The lambs were born during the last week of September and the first two weeks of October, and ewes and lambs were given kale and as much hay as they would eat during the night, when they were housed. During the first three months the lambs increased in weight at a satisfactory rate (*vide* Table I), but exceptionally dry weather was experienced during January and February and the pasture dried up almost completely, with the result that most of the ewes went dry. Unfortunately, in a desire to adhere strictly to the conditions implied in (*c*) above, the addition of extra foodstuffs in the form of concentrates was delayed too long and the lambs received a severe check in growth and condition. Feeding was commenced after the weighing on 5th February, but naturally it took a little time before the lambs became accustomed to the ration. After one week however they were consuming approximately half a pound per head of a mixture of equal parts of bran and maize meal. It is doubtful if the lambs were fed for a long enough period to enable them to derive any substantial benefit, since during the same time the pasture was progressively deteriorating; and in fact the group of lambs made less gain during this month than during the previous three weeks when no concentrates were fed.

The weights of the carcasses (Table I) were disappointing, but their conformation showed quite clearly the influence of the Southdown cross. After slaughter the carcasses were chilled at 30° F. for 30 hours, and were railed to Mombasa in an insulated ice-bunkered truck. On arrival at the Cool Store, Mombasa, at 11.45 a.m., the temperature inside the truck was 76° F., and the carcasses were immediately placed in a cool chamber at 20° F.; in the next four hours the temperature of the room was reduced to 14° F. During the following night the room temperature rose to 22° F., and with further working was again reduced to 14.5° F. at 4 p.m.; but again during the night there was a rise to 20° F. During the remaining five days in cold store the temperature ranged from 13° to 18° F.

TABLE I

Report No.	No.	Date of Birth	Weight at Birth	Weight 15–1–37	Weight 5–2–37	Weight 5–3–37	Dead-Weight	Smithfield Weights
			lb.	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
1	5141	29– 9–36	6	50	56	61	28	27
2	5147	7–10–36	5	48	52	55	23	22
3	5144	30– 9–36	7	53	57	58	24¼	23
4	5173	12–10–36	8	57	62	65	29	27
5	5143	29– 9–36	8	55	60	65	29	28
6	5145	30– 9–36	6	48	62	66	29	29
7	5137	24– 9–36	8	70	73	77	33½	32
8	5172	12–10–36	8	49	54	55	24¼	23
9	5138	25– 9–36	5	50	54	60	26¼	26
10	5142	29– 9–36	5½	52	55	59	27¾	26

The carcasses were shipped on the 16th March, i.e. ten days after slaughter, and travelled in the ship's meat room, of which the temperature with doors closed was 20° F.

The process of shipping occupied 24 minutes. It was stated that the usual temperature of the freezer with doors closed would be from 16° to 18° F.

The carcasses were released on Smithfield Market on the 15th April, 41 days after slaughter. Apparently they created a considerable amount of keen interest

among retailers, and relevant extracts from the reports of Messrs. Geo. C. Kean and Co., Ltd., Lieut.-Col. Dunlop Young and Dr. Grace, Chief Meat Inspector and Veterinary Officer, Central Meat Market, are appended, together with the sales account for the consignment:—

"We received the ten lamb carcasses. . . . The lambs were then sent to our Smithfield Market stall for examination, and in addition to Colonel Dunlop Young and the writer, Dr. White, Medical Officer of Health for the Port of London, and Dr. Grace, Chief Inspector at Smithfield Market, were present and inspected the lambs.

"In your letter A3/34A/698 you state that the consignment was a disappointing one. Apparently you got this impression because the lambs were rather light in weight, but, as a matter of fact, we were agreeably surprised with the quality of the lambs. They were certainly rather small in weight, but this is an advantage, because small-weight lambs, that is anything under 30lb., command a premium as compared with the heavier lambs. There were five carcasses particularly good, No. 5, No. 7, No. 9 and two from which the labels had disappeared. These two were apparently No. 6 and No. 1. There were two lambs, No. 7 and probably No. 6, judging by the weight, which were of outstanding merit, showing very clearly the characteristics of the Southdown. If you can produce lambs of this quality in any quantity you will always find a ready market for them here at prices which, we think, would be remunerative to your sheep growers.

"As regards the dressing, we do not want to be too critical about this experimental parcel, but there are one or two things which should be remedied in your next consignment. First, the breasts had not been opened up, and in this country it is the custom to open the carcass right from the legs to the scrag. In the second place, the shanks had been pushed through slits cut in the neck. This results in the shanks being pushed up into the shoulder, and to a retailer these necks and shoulders look not only unusual, but rather unattractive, particularly when the shoulder is cut off. We prefer that you use what we call neck-setts, that is a string is tied round the neck bones of the scrag and round the shanks, pulling the neck in a little bit and pulling the shanks as near as possible perpendicular when the carcass is hanging. We would also mention that in the case of two or three carcasses the gambril used had been too wide, with the result that the legs were too wide apart. Where a gambril of the proper size is used, the legs have a much thicker appearance. The worst feature about the dressing was that the legs and shoulders had been rather badly damaged in nearly every case when taking off the skin. The greatest possible care should be exercised, particularly on the inside of the legs and on the shoulders, to see that the flesh is not torn.

"The lambs were in a perfectly bright fresh condition, and great credit is due to whoever has dealt with the freezing of the carcasses.

"We do not know if stockinette is available in your country, but we would strongly recommend you to use stockinette instead of the thick linen which was used in this case. We would also mention that we had a complaint from one of the buyers that the linen had a very peculiar smell which, in the case of lambs going soft, might possibly affect the meat. All mutton and lamb coming into this country is wrapped in stockinette and, in the case of the Union of South Africa, their lambs arrive in a double stockinette. This is not absolutely necessary, but it does help to keep the carcasses clean.

"We understand that Colonel Dunlop Young is posting you fully as regards Government regulations, and no doubt before your next shipment the necessary regulations will have been issued. As regards the stamps on the legs, loins and shoulders, these were quite satisfactory, although rather faint. The letters used, however, were rather larger than those used on lambs from other countries, but this is not a serious matter.

"We noticed that the freight paid in Mombasa amounted to two guineas, and we suggested in one of our conversations with the Union-Castle Line that this appeared excessive. They replied that they could not do anything here, but indicated that, if you raised the question at your end, the ship's agents there would no doubt refer to London, where the matter would be favourably considered.

"We shall look forward with great interest to your next shipment of lambs, and can assure you that the small parcel we had yesterday created quite a lot of interest amongst retailers who were on Smithfield at the time."

(Sgd.) *Geo. C. Kean & Co., Ltd.*

Smithfield Market, London,

16th April, 1937.

"The condition in which the carcasses arrived was very satisfactory; altogether I must congratulate you on the very efficient way in which you have arranged the experimental consignment; and now for a few particulars which may help you in future.

"The breed, viz. Merino x Southdown, has produced a very suitable lamb for Smithfield Market. The shape of these lambs was very satisfactory; in fact, one of them, No. 7, was an absolute model, and quite equal to the best New Zealand or Australian lamb carcasses. It was admired by everybody who saw it, and, if you can send plenty of lambs of this type, there is no doubt whatever as to the success of your lamb trade.

"Reference to dressing, please note that the butcher had been careless or too severe in taking the skin off the legs, near to the hock, in that he had taken away with the skin most of the connective tissue, therefore the lean muscular tissue showed very plainly. The more subcutaneous tissue that can be left on the carcass the more attractive it is. The same remarks apply to the pulling off the skin of the cervical region, where the butcher had actually taken away the whole of the subcutaneous connective tissue. Tell him to leave both regions mentioned as white as possible by leaving as much as possible of the connective tissue on the carcass. Next, do not pull back the forelegs, or shanks as we call them, and insert them into the slit made in the jugular furrow. This spoils the appearance of forequarters.

"I am sending you a photograph which shows how the forelegs or shanks should be left, and I have marked with ink on one carcass the part that showed very bare on the hind leg.

"The breast or sternum had not been divided; the butchers here like the breast opened right down, that is, the slit beginning at the ischio-pubic symphisis should be continued right down to the throat or neck. It was also noticed that the carcasses were rather too much spread between the hind legs, probably due to the gambrel used being too wide; otherwise, as a first consignment, the butcher had done his work fairly well."

(Sgd.) *T. D. Young.*

39 Charterhouse Chambers, Charterhouse Square, Smithfield Markets, London, E.C.1.,

16th April, 1937.

"I thought it might interest you to know that I had the pleasure of inspecting the ten lamb carcasses consigned by you recently to Smithfield. Apart from the fact that they were unaccompanied by an official certificate, I had no difficulty in passing them into circulation. However, in this matter, and as regards dressing, etc., you have no doubt heard from your agents and Colonel Dunlop Young. I took the trouble to purchase one of the legs, and you will be interested to learn that flavour, texture and eating qualities were all that could be desired."

(Sgd.) *L. B. A. Grace,*
Veterinary Officer and Chief Meat Inspector.

Meat Inspector's Office, Central Markets,
Smithfield, London, E.C.1.
30th April, 1937.

No. G.C.K. 2271

ACCOUNT SALES of Ten Lambs *ex* S.S. "DURHAM CASTLE" ..... arrived LONDON 15–4–37 from MOMBASA, sold by order and for account of THE CHIEF VETERINARY RESEARCH OFFICER, VETERINARY RESEARCH LABORATORY, P.O. KABETE, KENYA, by GEORGE C. KEAN & CO., LTD., EMPIRE HOUSE, ST. MARTIN'S LE GRAND, E.C.1.

Mark : As under..... B/L Wt. : 252 lb.

Cons./Order No..... Invoice No..... Lot No. 566. A/Sales Wt. : 263 lb.

No.	C/cs.	Lb.	Average Price per lb.	£	s.	d.	£	s.	d.
			Pence						
1	1	27	7·50		16	10			
2	1	22	7·50		13	9			
3	1	23	7·00		13	5			
4	1	27	7·00		15	9			
5	1	28	7·50		17	6			
6	1	29	7·50		18	1			
7	1	32	7·50	1	0	0			
8	1	23	7·00		13	5			
9	1	26	7·50		16	3			
10	1	26	7·00		15	2			
							8	0	2
Cartage to market, tolls and pitching expenses ..					15	0			
Commission and Guarantee, at 4 per cent					6	5			
							1	1	5
							£6	18	9

It is quite evident from the reports on this consignment, which was produced under adverse conditions, that first cross Southdown-Merino lambs are suitable for the London fat lamb trade, and that there is no need for raising half-bred ewes, with all the complications that would arise with respect to wool-classing. This is an extremely important consideration for the sheep industry. If the Southdown-Merino cross is satisfactory, then it may safely be assumed that the Southdown-Romney cross, which is so frequently employed both in England and overseas, will yield an equally satisfactory lamb under the appropriate Kenya conditions. It is equally gratifying to find that these old Merino ewes did their lambs so well, as long as pasture condition allowed them.

We are convinced that under normal weather conditions the consignment would have been a much better one in respect of weights of carcasses. It is probable that lambs born in June and shipped in October and November would on the whole be likely to meet with more favourable grazing conditions, and we are informed that lambs marketed in November and December would command a premium, since this is the season during which New Zealand prime lambs would not be competing. Finally, with reference to the prices realized by the small consignment, it is to be remembered that the lambs were sold directly from the stall to retailers, and in order to make a comparison between this sale and those of large parcels of New Zealand and Australian lambs one should deduct one farthing per pound from the figures shown on the sales account.

It is perhaps remarkable that even after making this allowance two-thirds of the carcasses made a price equal to that of the best New Zealand lamb, in spite of the deficiencies in dressing that are referred to in the reports.

It is proposed to make further sample shipments of lamb-carcass of Southdown-Merino, Southdown-Romney Marsh, and Southdown-Boran crosses in time for the November market this year.

It is with great pleasure that we acknowledge the valuable assistance received from Mr. R. C. Yates, of the Municipal Abattoir, Nairobi, who supervised the dressing of the carcasses; Mr. L. Shoolman, Government Coast Agent, who personally made all arrangements for shipping, and Mr. C. L. Silvester, Chief Grader and Inspector, who, with his staff, was responsible for the freezing of the carcasses.

[RAm XVI, 838]

Annotated Host List of Uganda Parasitic Fungi and Plant Diseases—Part III

By C. G. HANSFORD, *M.A., F.L.S., Mycologist, Department of Agriculture, Uganda Protectorate.*

PAPILIONACEAE.

ALYSICARPUS sp. (Indigenous).

Uromyces alysicarpi (Doidge) Wakefield and Hansford, rust.

ARACHIS HYPOGEA (Groundnut).

Cercospora arachidicola Hori, leaf spot.

Cercospora personata (B. & C.) E. & Ev., leaf spot or "tikka" disease; of universal occurrence in Uganda, but on varieties in general cultivation little or no damage to the crop results, as no severe leaf-shedding occurs on infected plants.

Sclerotium rolfsii Sacc.,

Macrophomina phaseoli (Maubl.) Ashby, sterile stage *Rhizoctonia bataticola* (Taub.) Butl., and

Fusarium oxysporum Schlecht., f.: These three fungi cause wilt diseases of this crop. Though widely distributed in Uganda, the diseases are usually limited to single plants or small scattered groups of plants, and at present little economic damage occurs.

Rosette Disease, caused by a virus; several more or less distinct types of this disease have been found in Uganda (Ann. Rept. Dept. Agric. Uganda, Part II, 1934).

ASTRAGALUS sp. (Indigenous).

Uromyces astragali (Opiz.) Sacc., rust.

BAUHINIA sp. (Indigenous).

Uromyces congoensis Syd., rust.

Uromyces sp., near *goyazensis* P. Hen.. (? *U. pustulatus* Wakef.), rust on *B. fassoglensis*.

Alternaria bauhiniae Hansford, on leaves.

CAJANUS CAJAN (Pigeon Pea).

Colletotrichum sp., on ripening pods.

Cladosporium vignae Gard., prox., leaf spot.

Cercospora cajani P. Henn., leaf spot.

Rhizoctonia bataticola (Taub.) Butl., sterile stage of *Macrophomina phaseoli* (Maubl.) Ashby, root disease, common on old plants, but not an important disease.

Fusarium oxysporum Schlecht., f., causes wilt disease of this host, but is not of egneral distribution in Uganda.

Gibberella sp., *Nectria* sp., *Fusarium herbarum* (Cda.) Fr., and *Fusarium scirpi* var. *caudatum* Wr., are common on dead and dying plants, but no inoculation experiments have been carried out with these in Uganda.

Gibberella sp. is associated with a dieback, but its pathogenicity has not been proved.

CANAVALIA ENSIFORMIS (Sword Bean).

Elsinoe canavaliae Rac., attacks the leaves and stems; on the former it causes deformation and wrinkling, the surface is purplish, with a delicate bloom of spores; on the stems it causes scabs and warts, and in bad attacks may entirely prevent fruiting. It is often parasitized.

Heterosporium sp. occurs on leaves parasitized by *Elsinoe* and also on dead and dying leaves and stems.

Verticillium sp. (not *V. albo-atrum*) has been isolated from wilted plants.

CENTROSEMA sp. (Introduced).

Cercospora sp., leaf spot.

Alternaria tenuis Bolle, f., leaf spot.

CRAIBIA sp. (Indigenous).

Phyllachora millettiae P. Henn., on leaves.

CROTALARIA AGATIFLORA (Indigenous).

Parodiella perisporioides (B. & C.) Speg. var. *microspora* Theiss. & Syd., on leaves.

Aecidium crotalariae P. Henn.

CROTALARIA JUNCEA (Sunn Hemp).

Neocosmospora vasinfecta EFS., common on wilted leaves.

Fusarium oxysporum Schlecht., f., causes a wilt of this plant, and the wilted plants are often covered with a layer of conidia of *Fusarium scirpi* var. *caudatum* Wr., and more rarely *Nectria* and *Gibberella* perithecia are found on such plants.

Helminthosporium gigasporum, f., *javanicum* Penz., on the stems of moribund plants.

(?) A virus disease is suspected to occur on this host in Uganda, but in the absence of inoculations it is not possible to be certain of this. Affected plants show excessive branching of the upper parts, particularly the flowering branches, on which the flowers are sometimes replaced by bunches of small leaves, such plants being sterile.

CROTALARIA (Other Indigenous Species).
Meliola bicornis Wint., on leaves.
Parodiella perisporioides (B. & C.) Speg., and var. *microspora* Theiss. & Syd., occur on leaves.
Mycosphaerella crotalariae Petch, conidial stages *Phyllosticta crotalariae* Sacc. and *Cercospora crotalariae*, causes a leaf spot.
Neocosmospora vasinfecta EFS., on dead stems.
Sclerotinia sp., conidial stage *Botrytis* sp., leaf spot.
Uromyces harmsianus (P. Henn.) Doidge, rust.
Aecidium crotalariae P. Henn., rust.
Uredo crotalariae Diet., rust.
Colletotrichum sp., leaf spot and on pods.
Cephalosporium sp., on dead and dying stems.
Fusarium oxysporum Schlecht., f., associated with wilt disease of *C. striata* and *C. intermedia*; the dying plants are often overgrown with *F. falcatum* App. and Wr., and *F. solani* (Mart.) Wr.
Alternaria sp., rot of pods and seeds.

DESMODIUM sp. (Indigenous).
Meliola bicornis Wint., *M. bicornis* var. *galactiae* Stev., and *M. zollingeri* Gaill. var. *minor* Beeli, all on leaves.
Parodiella perisporioides (B. & C.) Speg.
Phyllachora desmodii P. Henn.
Uredo sp., rust.
Tetracoccosporium sp., parasite on *Meliola* on leaves.

ERIOSEMA sp. (Indigenous).
Woroninella eriosematis (P. Henn.) Syd., rust.
Meliola bicornis Wint., on leaves.

ERYTHRINA sp. (Indigenous and Introduced).
Meliola bicornis Wint.
Mycosphaerella erythrinae Koord., leaf spots.
Uredo erythrinae P. Henn., rust.
Armillaria mellea (Vahl.) Fr., root rot.
Cercospora erythrinae E. & Ev., leaf spot.
Rhizoctonia lamellifera Small, root disease, uncommon.

GLIRICIDIA SEPIUM.
Meliola bicornis Wint., on leaves.
The following are common on dead and dying branches:—
Nectria flavo-lanata B. & Br.
Calonectria rigidiuscula (B. & Br.) Sacc., conidial stage *Fusarium decemcellulare* Brick.
Hypomyces haematococcus (B. & Br.) Wr., and its *Fusarium* stage.
Gibberella baccata (Wallr.) Sacc.
Gibberella pseudocpulicaris Wr.

GLYCINE MAX (Soy Bean).
Cercospora (*cruenta* Sacc.?), leaf spot.
Rhizoctonia bataticola (Taub.) Butl., sterile stage of *Macrophomina phaseoli* (Maubl.) Ashby, root disease.
"Leaf Wrinkle", probably a virus disease.

GLYCINE sp. (Indigenous).
Woroninella dolichi (Cke.) Syd., "rust".
Meliola bicornis Wint.
Aphysa rhynchosiae (Kalch. & Cooke) Theiss. & Syd.

HALLIA sp. (Indigenous).
Uromyces sp., rust.

HEDYSARUM sp. (Indigenous).
Uredo sp., rust.

INDIGOFERA sp. (Indigenous).
Parodiella perisporioides (B. & C.) Speg., and var. *microspora* Theiss. & Syd., on leaves.
Uromyces orientalis Syd., rust.
Ravenelia indigoferae Wakef. & Hansf., rust.
Uredo indigoferae Doidge, rust.
Uredo maraguensis P. Henn., rust.

LUPINUS sp. (Cultivated Lupin).
Macrophomina phaseoli (Maubl.) Ashby, root disease.

MEDICAGO SATIVA (Lucerne).
Uromyces striatus Schroet., rust; this is often severe in Uganda, where the host appears to be near the limit of its range of climatic conditions; considerable defoliation results from attack, and growth is slow.
Macrophomina phaseoli (Maubl.) Ashby, root disease.
Sclerotium rolfsii Sacc., root disease.

ORMOCARPUM sp.
Uredo sp., indet., rust.

PHASEOLUS sp. (Indigenous, and Cult. Beans).
Oidium sp. (? of *Erysiphe polygoni* DC.), mildew; attacks are frequent, especially

in the cooler parts of the year, but little damage results from attack on most of the varieties of beans cultivated in Uganda.

Glomerella lindemuthianum Shear, conidial stage *Colletotrichum lindemuthianum* (Sacc. & Magn.) Br. & Cav., anthracnose; causes leaf-spots and spots on pods, the latter penetrating into the seeds; not of great importance in Uganda.

Pleospora sp., recorded from stems of beans.

Uromyces appendiculatus (Pers.) Lk., rust, of universal occurrence in Uganda; native bean varieties appear to differ in resistance to attack, but hitherto no attempts have been made to determine the damage due to the disease, or to isolate resistant bean varieties.

Ascochyta sp. are common on beans in Uganda, causing large leaf and pod spots; the separation and identification of the forms concerned has not yet been carried out; on some beans considerable leaf-shedding occurs.

Cladosporium album Dowson, f., attacks beans, forming white patches on the lower surface of the leaves; little damage appears to result from attack.

Cercospora cruenta Sacc., leaf spot.

Isariopsis griseola Sacc., very common leaf spot, especially in moist weather; some defoliation may result from severe attack.

Macrophomina phaseoli (Maubl.) Ashby, with sterile stage *Rhizoctonia bataticola* (Taub.) Butl., root disease, usually mainly on plants growing on poor soil; widely distributed. The disease is usually limited to a few plants in a plot.

Rhizoctonia solani Kuhn (*Corticium vagum* B. & C.), root disease, chiefly on young plants.

Cercospora canescens E. & M., and *Speira* sp. are common on old leaves and stems.

PISUM SATIVUM ARVENSE (Field Pea).

Oidium sp. (? of *Erysiphe polygoni* DC.), mildew; very common in Kigezi, where the crop is grown on a large scale; the damage has not been assessed.

Macrophomina phaseoli (Maubl.) Ashby, root disease; not common.

Cladosporium album Dowson, f., leaf spot.

PSEUDARTHRIA sp. (Indigenous).

Catacauma sp., on leaves.

Meliola bicornis Wint., on leaves.

Uromyces pseudarthriae Cooke, rust.

Cercospora pseudarthriae Petch., leaf spot.

PUERARIA sp.

Aecidium vignae Cooke, rust.

RHYNCHOSIA sp. (Indigenous).

Aphysa rhynchosiae (K. & C.) Th. and Syd., on leaves.

SESBANIA sp.

Uredo sesbaniae P. Henn., rust.

Rhizoctonia lamellifera Small, root disease.

MUCUNA DEERINGIANUM (Velvet Bean).

Cercospora mucunae Syd., leaf spot.

Uromyces mucunae Rabh., rust.

Phyllosticta mucunae E. & Ev., leaf spot.

TEPHROSIA sp. (Indigenous and Introduced).

Elsinoe tephrosiae Hansford, small scabs on leaves, petioles and stems; on the stems these become infected with *Fusarium* sp. and *Gibberella* sp., and a rot of the stem occurs; finally the stem or branch breaks off.

Oidium sp., mildew.

Parodiella perisporioides (B. & C.) Speg., on leaves.

Meliola bicornis Wint., var. *tephrosiae* Beeli, on leaves.

Neocosmospora vasinfecta EFS., on dying stems.

Uredo sp., rust.

Scolecotrichum sp., leaf spot.

Cylindrosporium tephrosiae Hansford, leaf spot.

Cryptocoryneum sp., leaf spot.

Macrophomina phaseoli (Maubl.) Ashby, root disease.

TERAMNUS sp. (Indigenous).

Meliola bicornis Wint., on leaves.

VICIA FABA (Broad Bean).

Uromyces fabae (Pers.) De Bary, rust.

VICIA SATIVA (Indigenous Vetch).

Uromyces fabae (Pers.) De Bary, rust.

VIGNA UNGUICULATA (Cowpea).

Woroninella dolichi (Cke.) Syd., "rust", causes severe malformation of leaves and stems of some types of cowpea, and of native wild species of *Vigna*.

Oidium sp., mildew, does little damage.

Uromyces appendiculatus (Pers.) Lk., rust; prevalent, but apparently causes little damage.

Ascochyta phaseolorum Sacc., causes large leaf spots, and with
Colletotrichum lindemuthianum (Sacc. and Magn.) Br. & Cav., causes severe defoliation of some varieties.
Cladosporium (*vignae* Gardn.?), leaf spot.
Cercospora cruenta Sacc., leaf spot.
Alternaria sp., leaf spot.
Macrophomina phaseoli (Maubl.) Ashby, root disease.
Parodiella perisporioides (B. & C.) Speg. and *Phyllachora* sp. occur only on wild *Vigna* sp.

VOANDZEIA SUBTERRANEA (Bambara Groundnut).
Cercospora sp., leaf spot.
Macrophomina phaseoli (Maubl.) Ashby, root disease.

ZORNIA sp.
Puccinia zorniae McAlp., rust.

HOST indet.
Morenoella sp.
Meliola teramni Syd.

MYRICACEAE.

MYRICA sp.
Dothidina disciformis Th. & Syd., on leaves.

CASUARINACEAE.

CASUARINA sp.
Rhizoctonia lamellifera Small, root disease.

MORACEAE.

ARTOCARPUS INTEGER (Jak Fruit).
Rhizoctonia lamellifera Small, root disease.

FICUS sp. (Indigenous).
Irenina obesa (Speg.) Stev., on leaves.
Meliola ficium Yates, on leaves.
Diplochorella fici Hansford, on leaves.
Phyllachora amaniensis P. Henn.
Phyllachora Dawei Masseee, on leaves.
Catacauma elmeri Syd., on leaves.
Catacauma repens (Cooke) Th. & Syd., on leaves.
Catacauma ulcerata (Massee) Th. & Syd., on leaves.
Mycosphaerella fici Hansford, on *F. ovata.*
Kuehneola fici Butl., rust.
Armillaria mellea (Vahl.) Fr., root rot.
Colletotrichum sp., on fruit.
Capnodium sp., sooty mould.
Fusarium moniliforme Sheld., rot of fruit.

MORUS sp. (Mulberry).
Mycosphaerella moricola (Fckl.) Lin., conidial stage *Septogloeum mori* (Lev.) Br. & Cav., leaf spot.
Septobasidium sp.

URTICACEAE.

BOEHMERIA NIVEA (Ramie Fibre).
Ascochyta boehmeriae Woron., leaf spot.
Colletotrichum boehmeriae K. Saw., leaf spot.
Cercospora boehmeriae Hansford, leaf spot. These three fungi cause considerable defoliation of plants growing on poor soil.

CANNABINACEAE.

CANNABIS SATIVA (Hemp).
Cercospora cannabina Wakef., leaf spot.

CELASTRACEAE.

GYMNOSPORIA sp. (Indigenous).
Irenina gymnosporiae (Syd., H. & P.) Stev.
Pestalozzia celastri Tassi.

LORANTHACEAE.

LORANTHUS sp. (Indigenous).
Clypeolina sp., on leaves.
Aecidium cookeanum De Toni, rust.
Septobasidium sp.
Dendryphium loranthi Hansford.

VISCUM sp. (Indigenous).
Aecidium cookeanum De Toni, rust.

RHAMNACEAE.

GOUANIA sp. (Indigenous).
Puccinia gouaniae Holw., rust.

RHAMNUS sp. (Indigenous).
Aecidium sp., rust.

HOST indet.
Irenina sp. and *Asterina* sp., on leaves.

VITACEAE.

CISSUS sp. (Indigenous).
Plasmopara viticola (B. & C.) Berl. and De Toni, downy mildew.
Schroeteria cissi (DC.) De T.
Uredo sp.
Aecidium vitis ALS., rust.

LEEA GUINEENSIS (Indigenous).
Irenopsis leeae Hansford & Stevens.
Phyllachora leeae Koord.

VITIS VINIFERA (Grape).
Plasmopara viticola (B. & C.) Berl. and De Toni, downy mildew.
Uncinula necator (Schw.) Burr., in its *Oidium* stage, mildew.

HOST indet.
Meliola bakeri Syd., on leaves.
Asterina sp., on leaves.

RUTACEAE.

AEGLE MARMELOS (Bael Fruit).
Oidium tingitanianum Carter, mildew on seedlings.

CITRUS sp. (Orange, Lemon, Grapefruit, etc.).
Elsinoe fawcetti Bitan. & Jenkins, with conidial stage *Sphaceloma fawcettii* Jenkins, citrus scab, on leaves and twigs, especially on young trees; some varieties of lime are particularly susceptible to this disease in Uganda. The above identification awaits confirmation, as cultures do not correspond exactly to the descriptions of this species.
Chaetomium trigonosporum (March.) Chiv., on dead and dying tissues.
Glomerella cingulata (Ston.) Spauld. and Schrenk, conidial stage *Colletotrichum gloeosporioides* Penz., anthracnose, leaf spot, and fruit rot; none of these are important diseases in Uganda.
Penicillium glaucum Lk., and *P. italicum* C. Wehm., rot of fruit.
Cladosporium citri Mass. (?), on scab lesions, probably a form of *C. herbarum*, a universal saprophyte in Uganda.
Nematospora coryli Pegl., a dry rot of fruit; rare.
Alternaria citri Pierce, leaf spot and fruit spot.
Rhizoctonia lamellifera Small, root disease, uncommon on this host in Uganda.
Cephaleuros mycoidea Karst., an alga, which forms greenish and reddish spots on the leaves, especially under wet conditions.
A number of fungi are common on dead and dying twigs of *Citrus* in Uganda, among which are *Stilbella* sp., *Sporocybe* sp., *Phoma* sp., and *Fusarium* sp. All appear to be saprophytic. *Saccardoea* sp. has been isolated from mummified fruit.

TECLEA sp. (Indigenous).
Meliola tecleae Hansford, on leaves.
Limacinia transvaalensis Doidge, on leaves.
Schiffnerula sp., on leaves.
Puccinia tecleae Pass., rust.
Ctenoderma toddaliae (Petch) Syd., rust.
Uredo sp., rust.

SIMARUBACEAE.

HARRISONIA sp. (Indigenous).
Cercospora sp., leaf spot.

MELIACEAE.

CEDRELA TOONA.
Capnodium brasiliense Putt. (?), sooty mould.

EKEBERGIA sp. (Indigenous).
Meliola ekebergiae Hansford, on leaves.

TRICHILIA sp.
Meliola trichiliae Beeli (*M. opposita* Syd.) on leaves.
Meliola thomasii Hansford, on leaves.

SAPINDACEAE.

ALLOPHYLLUS sp. (Indigenous).
Meliola furcillata Doidge, on leaves.
Meliola nephilii, var. *major* Hansford and Stev., on leaves.
Mycosphaerella conferta (Speg.) Wakef., leaf spot.

CARDIOSPERMUM sp. (Indigenous).
Meliola cardiospermi Hansford & Stev., on leaves.

DEINBOLLIA sp. (Indigenous).
Meliola deinbolliae Hansford.

PAULLINIA PINNATA (Indigenous).
Meliola paulliniae Stevens, on leaves; often parasitized.

MELIANTHACEAE.

BERSAMA sp. (Indigenous).
Meliola bersamae Hansford,
Meliola bersamicola Hansford,
Irenina bersamae Hansford,
Englerulaster bersamae Hansford,
Cycloschizon bersamae Hansford,
Physalospora bersamae Syd.,
Scolecopeltis sp.
Micropeltis ugandae Hansford.
Lembosina sp.
All the above occur on the leaves.

ANACARDIACEAE.

ANACARDIUM OCCIDENTALE (Cashew Nut).
Limacinia anacardii Hansford,

Pestalozzia palmarum Cooke,
Teratosperma anacardii Hansford,
All on leaves.

MANGIFERA INDICA (Mango).
Erysiphe cichoracearum DC., mildew of inflorescence, causing considerable loss of fruit in many areas.
Armillaria mellea (Vahl.) Fr., root rot, uncommon on this host.
Glomerella cingulata (Ston.) Spauld. and Schrenk, ripe rot of fruit.
Cercospora sp., leaf spot.

PSEUDOSPONDIAS sp. (Indigenous).
Morenoella sp. and *Scolecopeltis* sp., on leaves.

RHUS sp. (Indigenous).
Meliola geniculata Syd. & Butl. (?).
Meliola rhois P. Henn., and var. *minor* Hansford, on leaves.
Meliola weigeltii Kze., on leaves.
Schiffnerula sp., on leaves.

ARALIACEAE.

ARALIA sp.
Rosellinia bothrina (B. & Br.) Sacc.
Rhizoctonia bataticola (Taub.) Butl., root disease of cuttings.

POLYSCIAS FULVA (Indigenous).
Helminthosporium fulvae Hansford, on leaves.

UMBELLIFERAE.

HETEROMORPHA sp. (Indigenous).
Aecidium heteromorphae ALS., rust.

HYDROCTYLE sp. (Indigenous).
Septoria nesodes Kalch., leaf spot.

PEUCEDANUM GRAVEOLENS (Dill).
Cercospora anethi Sass., leaf spot, severe.

PEUCEDANUM sp. (Indigenous).
Uredo sp., rust.

ERICACEAE.

ERICA sp.
Dimerosporium elliotii ALS.
Aloysiella ruwenzoriensis Matt. & Sacc.

EBENACEAE.

BUTYROSPERMUM PARKII (Shea Nut).
Cercospora sp., leaf spot.

MIMUSOPS sp. (Indigenous).
Meliola mimusops Hansford & Stevens, on leaves.

MYRSINACEAE.

MAESA LANCEOLATA (Indigenous).
Amazonia peregrina Syd.
Meliola groteana Syd.
Meliola maesae Hansford & Stevens.
Physalospora chaenostoma Sacc.
All on leaves.

LOGANIACEAE.

ANTHOCLEISTA sp. (Indigenous).
Coccodothella anthocleistae Hansford, on leaves.

BUDDLEJA sp.
Rhizoctonia lamellifera Small, root disease.

OLEACEAE.

JASMINUM sp. (Indigenous).
Meliola jasmini Hansford & Stevens.
Uromyces hobsoni Vize, rust.

APOCYNACEAE.

ALAFIA sp. (Indigenous).
Cercosporella alafia Hansford.

FUNTUMIA sp. (Indigenous).
Meliola funtumiae Beeli, and var. *hamatus* Hansford & Stevens.
Asterina sp.
Actinopeltis funtumiae Hansford.
Dictyopeltis gigantospora Hansford.
Micropeltella funtumiae Hansford.
Scolecopeltis macrospora Hansford.
Micropeltella ugandae Hansford.
Nectria flavo-lanata B. & Br., on stems.

LANDOLPHIA sp. (Indigenous).
Penicillopsis dybowskii Pat., on seeds.
Asterina sp.
Scolecopeltis sp.
Meliola landolphiae Hansford.

MOTANDRA sp. (Indigenous).
Asterina sp.

STROPHANTHUS sp. (Indigenous).
Hemileia strophanthi Rac., on *S. hispidus*, rust.
Hemileia smallii Hansford, on *S. courmontii*, rust.
Dictyopeltis gigantospora Hansford.
Meliola strophanthi Hansford.

VOACANGA OBTUSA (Indigenous).
Meliola voacangae Hansford.
Colletotrichum sp.

(To be continued)